WASHINGTON, D. C.
1910

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AMERICAN BREEDERS MAGAZINE

Published by the American Breeders Association

A Pheasant-Bantam Hybrid
H. J. WHEELER

Natural Crossing in Cotton
H. A. ALLARD

Observations on Breeding Grapes
T. V. MUNSON

Improvement of Sugar Cane
HAMILTON P. AGEE

Breeding for Timber Improvement
GEORGE L. CLOTHIER

Field Workers' Meeting, Eugenics Section

Fourth Quarter | Oct., Nov., Dec.

Vol. I | No. 4

tered as second-class matter June 10, 1910, at the Post Office at Washington, D. C., under the Act of July 16, 1894

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Membership: Annual, $2.00; Life, $20.00; Patrons, $1,000.

The American Breeders Magazine

Published Quarterly by the American Breeders Association

FOR THE USE OF ITS MEMBERS

PRICE OF SINGLE COPIES, 35 CENTS

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Vol. I. Fourth Quarter, 1910. No. 4.

CONTENTS.

	Page
Ephraim Wales Bull (portrait)	238
Bull, Gideon, and Budd (biographical sketches)	239
Peter M. Gideon (portrait)	241
Joseph Lancaster Budd (portrait)	244
Preliminary Observations Concerning Natural Crossing in Cotton. H. A. Allard	247
Breeding to Improve Physical Qualities of Timber. George L. Clothier	261
Report of Committee on Breeding Fish. John W. Titcomb	263
A Pheasant-Bantam Hybrid. H. J. Wheeler	266
Propagation of Seedlings of Sugar Cane in Louisiana. Hamilton P. Agee	269
Single Character vs. Tout Ensemble Breeding in Grapes. T. V. Munson	274
Details for a Game Breeders' Law. Dwight W. Huntington	280
The Breeding of Grain Sorghums. Carleton R. Ball	283
Report of Committee on Breeding Cotton	293
EDITORIALS:	
Breeding, Research, and Education	296
Creation of Varieties and Breeds	298
Procedure with Self and Open-Pollinated Varieties	300
Creating and Improving Breeds of Animals	302
Mutation Theory Most Valuable in Breeding	303
NEWS AND NOTES:	
Eugenics Section	304
Meeting of the Eugenics Section	304
The Fourth International Genetic Conference	307
Recent Publications and Articles	309
ASSOCIATION MATTERS:	
The Seventh Annual Meeting at Columbus, Ohio	310
Program Seventh Annual Meeting	311
A. B. A. Membership an Acceptable Gift	315
What Others Say	315

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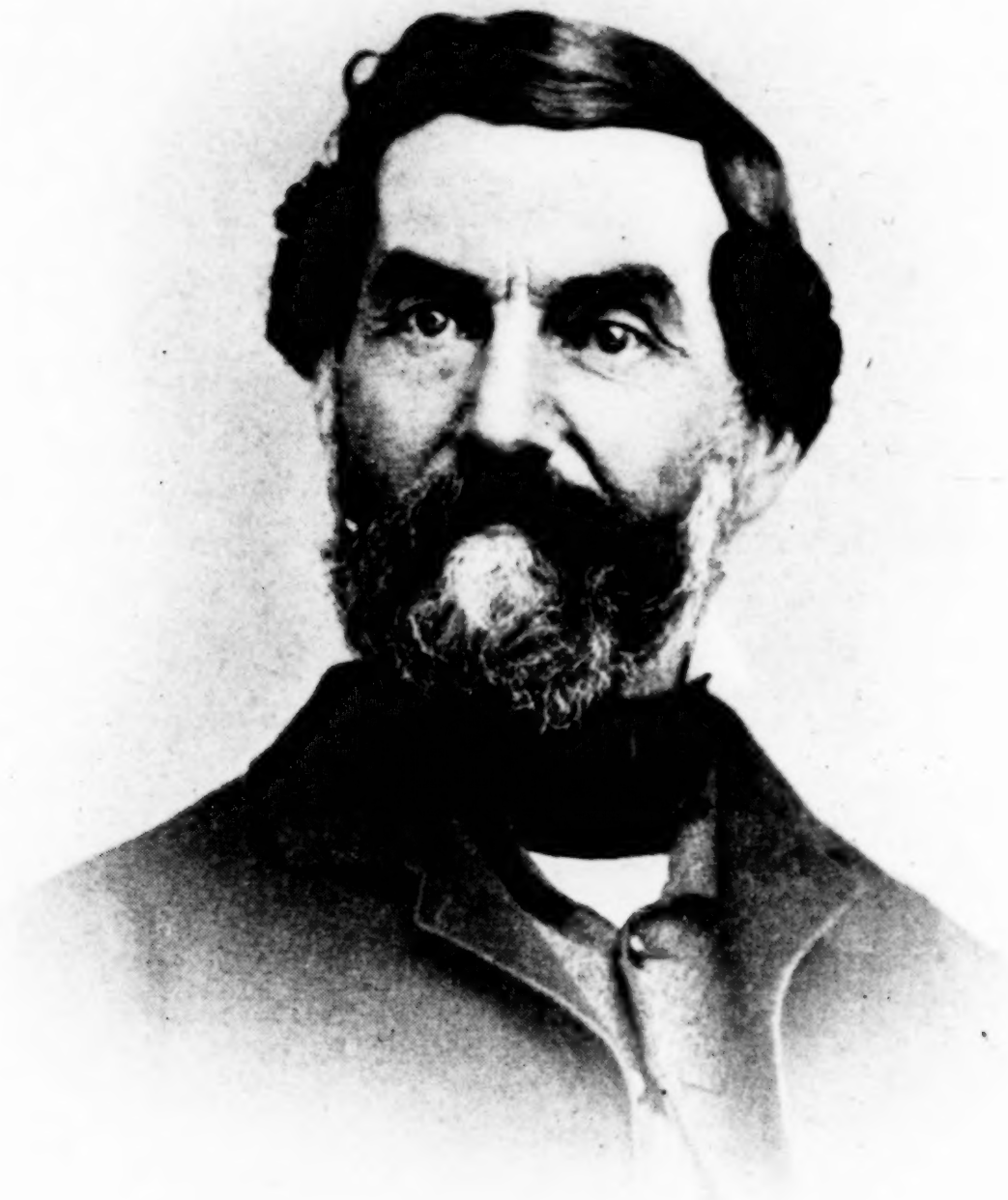


EPHRAIM WALES BULL.

THE AMERICAN BREEDERS MAGAZINE

"Our oldest cultivated plants, such as wheat, still yield new varieties; our oldest domesticated animals are still capable of rapid improvement or modification."
—CHARLES ROBERT DARWIN.

Vol. I. Fourth Quarter, 1910. No. 4.

BULL, GIDEON, AND BUDD.

Ephraim Bull gained a place of honor among those successful pioneers who achieved large things before the days when breeding was taught in the schools. He originated the Concord grape, thus making possible the growing of hardy grapes of high quality at low cost in the Northern States and in the colder temperate regions of the earth. He also wrought out much of the science and practice of breeding grapes and other plants which are multiplied clonally, by cuttings or buds.

Peter Gideon stands first among the pioneers in the work of extending hardy tree fruits beyond the former northern limits of the fruit zone. This rugged mind in creating the Wealthy apple and other hardy fruits inspired the people with faith that they can surround their homes with fruit trees, and thereby placed all cold countries under obligations to him.

Professor J. L. Budd was first among the pioneer teachers of plant breeding in our State colleges of agriculture. Twenty-five years ago, when the botanists of the United States Department of Agriculture were debating the propriety of using the term "plant breeding" in their publications, Professor Budd was training and inspiring the first group of college-made plant-breeding experts. He also performed great service as the first of American agricultural explorers to bring new plants from foreign lands, and as one of the pioneers in American horticulture and forestry.

These men believed that to obtain new varieties of fruit or trees peculiarly suited to the needs of the climatic and cultural conditions of their respective sections of country new forms could be called into existence through breeding. Thus they effected recombinations of unit characters in countless thousands of individuals, until one

containing the desired qualities and characteristics was evoked out of the number of infinite possibilities. The century now before us is witnessing a more scientific approach to breeding operations in the creation of new fruits, trees, and flowers, and no doubt other men of genius will earn fame for themselves, but the permanent benefits to horticulture wrought in the past century by these three strong characters will endure as a monument to their memories.

EPHRAIM WALES BULL.

1806-1895.

Ephraim Bull, in breeding new varieties of grapes, created the Concord. It was not a foundling or chance seedling, but the result of very patient work and waiting, not taking into account the many preceding years spent in experimentation and futile trial. Hundreds of failures in grape growing finally led him to recognize that only in a native grape could be found the mother of the hardy American grape which he desired to produce. Such mother was a *Vitis labrusca* plant on his farm, and from the seeds of this plant sprang the Concord. Eleven years were spent in growing and perfecting seedlings and in testing the selection. In 1853 the Concord was for the first time placed upon exhibition and the stock placed upon the market. Although the first vines were sold at a good price, the control of the stock quickly passed out of Mr. Bull's hands and he reaped very little benefit from it. Ten years later the Concord grape was spread over the entire northern part of the United States and is now widely used in temperate regions of most parts of the earth.

He originated other varieties of grapes, such as the Cottage, Esther, Rockwood, Iona, August Rose, and also many other but unnamed sorts. That there were no really hardy American varieties in existence and that horticulturists were experimenting with European varieties all the more emphasizes the genius of Mr. Bull in originating the Concord after many years of patient work. The Catawba and Isabella, two southern varieties, were among the improved American varieties then in existence. From Mr. Bull's statement that: "From over twenty-two thousand seedlings, there are twenty-one which I consider valuable," one may gain an idea of the numbers handled by him.

Peter McGideon.

Born in 1806, Mr. Bull's vocation was that of a gold beater, which he followed in Boston. A small garden afforded him the opportunity to carry on his plant-breeding operations in spare moments. Failing health in 1836 having forced him to give up his business, he moved to Concord, Mass., where he purchased a farm of 17 acres not far from the site of the historic bridge. Here he began his earnest search for the mutant grape which was to be a valuable and permanent addition to American horticulture.

Ephraim Bull counted many of the brightest minds of his day among his friends. He cultivated an intimate friendship with Hawthorne, who was his neighbor; also with Agassiz, who induced him to lecture on the grape at Harvard University. He was an indomitable worker, a close observer, a clear thinker, and a philosopher. He was a useful citizen in his community, having served it as selectman, legislator, member of the school committee, and member of the State Board of Agriculture. As a lover of outdoors, he took much delight in planting trees. He greatly adorned his home place, the beauty of which has remained undisturbed to this day.

Mr. Bull died at the age of 89 and the passers-by are informed by the epitaph on the plain slab marking Ephraim Bull's grave that "He sowed, others reaped." Whether the idea which dominated him absorbed him to the degree of neglecting all else, or whether he simply lacked the cunning requisite to accumulate property is a question which here may well be left undecided. He died neglected, in poverty, broken in spirit, all but forgotten. He left the world a fruit which has contributed to the wealth and welfare of entire States, and the aggregate, if computable, would be a sum numbering many millions, but even more valuable than this, he gave inspiration which has helped to make plant breeding one of the great forces in cheaply feeding the world.

PETER M. GIDEON.

1818-1899.

Peter M. Gideon, in his work in the third quarter of the nineteenth century, had little else to guide him than his breeder's instinct.

Intuition told him that a mingling of the blood of such fruits as the crab-apple with that of the common apple or *Pyrus malus* type might lead to the production of a very hardy apple useful in the far north. He did not relax his efforts until he had produced the Wealthy

apple, which he named for his wife, whose maiden name was Wealthy Hall. The Wealthy was Gideon's masterpiece. It earned for him a national reputation and the name Wealthy is to be found in catalogues of many foreign lands, and that name will go down to posterity with the name of Peter Gideon.

While the Wealthy apple is adding many millions to the wealth of this and other nations, Gideon's larger work lies in the fact that he gave inspiration to many breeders of plants. He demonstrated that through persistent effort we can so improve many of our varieties of fruits in hardiness that they may be grown farther north. This inspiration is beginning to make possible the family orchard and family fruit gardens farther north along the coldest zones of agricultural production and farm homes. Mr. Gideon also added something to the science of plant breeding.

Peter M. Gideon was born in Champaign County, Ohio. From his earliest boyhood his interest was in horticulture. In 1841 he moved to Illinois and in 1853 to Minnesota. He settled on a partially wooded farm protected by the arms of beautiful Lake Minnetonka. In these very earliest days of Minnesota he began to plant trees and to grow trees from seeds. After ten years of labor, expense, and waiting a cruel Minnesota winter destroyed every one of his trees. Undismayed and indefatigable, he began again, and this time succeeded. There is rugged pathos in the story of his early struggles and in the privation of his family. The story is authenticated that he borrowed money with which to send to Maine to buy apple seeds when he was in dire need for a coat to wear so that he could go out and chop wood to exchange for groceries. The Wealthy apple came from one of the many seeds thus secured. Other varieties of great merit which he produced are Gideon, Martha, Peter, September, and October.

For a time the State of Minnesota employed him on his experiment farm that he might continue his work of originating hardy fruits. During his declining years the State Horticultural Society honored Mr. Gideon by making him its special experimenter under a small annual salary, and upon his death it provided a monument to his memory.

Peter Gideon was a man of peculiar beliefs; somewhat uncompromising in his opinions, but a natural lover of trees and flowers and of a very kindly disposition toward man. Although he exhibited

JOSEPH LANCASTER BUDD.

fruit from his orchards at fairs and expositions and always had collections of surpassing value, quality, and interest, he held too high a conception of the dignity of his creative work to compete for and accept money premiums. His gardens were always at the disposal of his neighbors and he would put himself to much trouble to get flowers for his children friends, and while securing immense wealth for others he was successful in accumulating only a modest wealth for himself.

JOSEPH LANCASTER BUDD.

1825-1902.

Professor J. L. Budd was a commanding figure in horticultural work during the first third of a century of the existence of the American land grant colleges. He organized the horticultural department of Iowa State College and was the first professor of forestry in any American agricultural college. He was successful as a teacher and possessed remarkable initiative as an experimenter. His explorations in the early eighties in Russia and other foreign countries marked the beginning of the systematic introduction of plants into this country under public auspices. He thus introduced in the northwest part of Iowa many new fruits, forest trees and ornamental plants. Some of these have proven directly of much value and others are valuable as sources of hardy blood to serve in making hybrids from which valuable hardy varieties may be chosen for the colder regions of this country.

So far as the writer knows, Professor Budd was the first American teacher to give instruction in plant breeding as a science and as a technical college subject. Under his inspiration were trained the first group of college men who took up the subject of organizing American plant breeding and of creating new varieties by scientific methods. A number of these men have met with large success and have in turn educated large numbers of plant breeders.

During the summer of 1882 Professor Budd, accompanied by Thero Gibbs, of Canada, went to Europe and Asiatic Russia for the purpose of studying horticultural problems. Their expense was paid by the Iowa State Legislature and the Canadian Government. This exploration resulted in the introduction of many hardy varieties of fruit trees, shrubs, and forest trees. His work with the introduction of Russian cherries was expecially important and resulted in many

valuable varieties. He carried on numerous experiments with apples and with roses.

Professor Budd was born at Peekskill, Westchester County, New York. When a young man of twenty he moved to Illinois and later purchased a farm in Benton County, Iowa, where he established a commercial nursery. He took a very active interest in the horticultural affairs of the State and was secretary of the Iowa State Horticultural Society from 1870 to 1902. Besides his work for the Horticultural Society, he contributed largely on horticultural subjects to the agricultural papers of his State.

His status as a horticulturist was peculiarly recognized by Charles Downing, who willed to Professor Budd his large library and notes. In 1902 Professor Budd published, with his former pupil, Professor N. E. Hansen, two volumes of the "American Horticultural Manual."

Contemporaneous with Roberts of Cornell, Stockbridge of Massachusetts, Newman of South Carolina, Knapp of Iowa, Sanborn of Missouri, and other practical pioneers without technical collegiate training in agriculture, Professor Budd did his part in giving scientific direction and inspiration to the first crop of trained agricultural technicians turned out by our State colleges.

Professor Budd's business experience was very satisfactory. He accumulated a small fortune in his early manhood as a commercial nurseryman. This enabled him during more than a quarter of a century to devote his undivided energies to his teaching and experimenting. He loved flowers and trees, and originated by cross-breeding a number of varieties of roses.

PRELIMINARY OBSERVATIONS CONCERNING NATURAL CROSSING IN COTTON.

H. A. ALLARD, *U. S. Department of Agriculture.*

INTRODUCTION.

Where it is intended to secure pure seed of any crop by careful methods of breeding and selection, one of the most essential considerations is first to determine to what extent the blossoms are self-fertilized or cross-fertilized. Corn is naturally adapted to extensive wind pollination, and most corn breeders, after careful investigation, concede that persistent inbreeding results in deterioration. Other crops, such as wheat, oats, and many legumes, have quite fixed the habit of self-fertilization.

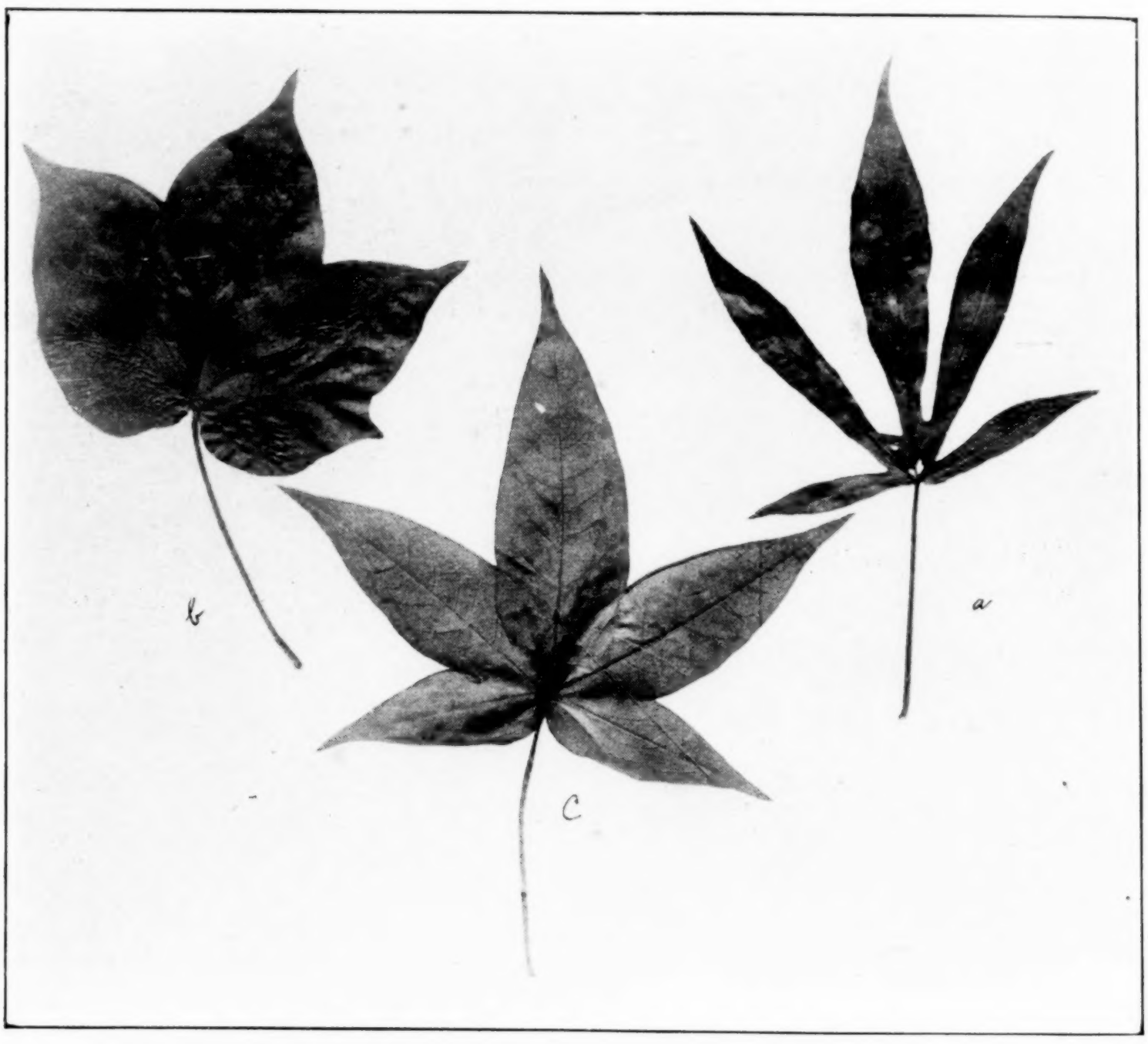
In breeding crop plants, the usual method consists in making centgener comparisons by the isolation of the progeny of promising individuals. It is at once evident that the degree of isolation of these progeny rows must depend essentially upon the readiness with which they may be cross-pollinated by the agency of wind, birds, or insects. Corn is so readily intercrossed by means of air currents that a progeny can be kept pure only by wide isolation. On the other hand, close-fertilized plants like wheat, oats, or soy beans may be planted within very narrow limits without serious chances of crossing.

NATURAL CROSSING, AN OVERLOOKED FACTOR IN COTTON.

Within recent years many skilled plant breeders throughout the world have turned their attention to the improvement of the cotton plant. At the very outset it appears that no serious attempt has been made to determine to just what extent cotton blossoms may be cross-pollinated by natural agencies under field conditions. While it is generally understood that all American cottons may readily be intercrossed by artificial methods, as in the hand-pollination to produce hybrids, it is not so generally believed that extensive natural crossing may take place. In fact, most cotton breeders and growers have surmised that that the factor of crossing must be very small, not affecting more than 5 to 10 per cent of the seeds. This view has been so generally accepted that natural crossing in cotton has been ignored as too small a matter for consideration. Cook,[a] however, in reporting on his work in Arizona, has contended that natural crossing in cotton is very

[a] Cook, O. F., "A Study of Diversity in Egyptian Cotton," Bulletin 156. Bureau of Plant Industry, U. S. Dept. of Agriculture, pp. 34-35.

frequent. Balls,[b] also working in Egypt, concludes from his later work that the amount of natural crossing there amounts to from 5 to 25 per cent by actual proof. From preliminary evidence now at hand, the writer is also convinced that natural crossing must be considered a most important factor, not only in all technical cotton-breeding problems, but also in the extensive field operations of the practical grower who wishes to secure increased yields and higher quality. In



LEAVES OF COTTON PLANTS.

a, Okra ; *b*, Keenan ; *c*, first generation hybrid between *a* and *b*.

connection with a new line of plant nutrition investigations, efforts were recently begun in South Carolina and Georgia to determine the specific effects of climatic, soil, and fertilizer factors upon the oil and nitrogen content of cotton seed. It was realized at the very start that more definite evidence must be secured as to changes arising from

[b] Balls, W. L., "Some Cytological Aspects of Cotton Breeding," Proceedings of American Breeders Association, Vol. V, page 27.

intercrossing. The problem resolves itself into two phases: (1) To determine the number of blossoms crossed; (2) and, most important, to determine the actual number of crossed ovules. Owing to a serious interruption of the experiment in the spring, the writer could secure definite figures only for the number of bolls crossed.

In a test to determine the percentage of crossing in cotton, such varieties must be used as will readily show hybrid features in the first generation. In a cross of the pure cut-leaved Okra type of cotton or the pure Willet Red variety upon green-leaved upland cottons, the leaf characteristics of the hybrids make their identification unmistakably apparent. In those hybrids where the okra-leaved type is the male parent, the identification of the hybrid depends upon a modification in the shape of the leaf. If the red-leaved variety is crossed upon the green, the hybrid plant is readily identified by the red coloration which affects all its parts. The accompanying figure shows the Okra (*a*) and the Keenan (*b*) type of leaf, and the intermediate (*c*) leaf shape of the hybrid.

As the photograph clearly shows, the hybrid leaf is in shape as nearly intermediate between the two parents as a theoretical conception could have made it. A cross of the red-leaved variety on the green is even more apparent; but, because the differences are in color only, the contrast is not sufficiently shown in a photograph.

ARRANGEMENT OF PARENT TYPES TO DETERMINE NATURAL CROSSING.

In an arrangement of the parent types in the field, two methods may be followed. If the varieties are planted in alternate rows, hybrids can appear only where cross-pollination has taken place from row to row.

If the plants alternate in the rows, cross-pollination takes place not only from row to row, but among the unlike plants within each row. In either case, theoretically, the number of plants of each variety remains the same. It is probable, however, that intercrossing between the two varieties is more readily facilitated when plants are arranged alternately in the rows.

In the actual practice of cotton breeding, where the usual method has been to plant the progenies side by side, it is perhaps more important to guard against free crossing among the progenies than among plants of the same progeny. Yet in the past the work of continued selection of the best plants within the progenies has been

based upon the belief that these plants must breed true to their type because of the assumed natural process of close-fertilization of the blossoms.

PLAN OF EXPERIMENT IN NORTHERN GEORGIA.

During the progress of cooperative breeding work begun in northern Georgia in 1908, the writer made plans to determine as accurately as possible the approximate amount of natural crossing occurring in the cotton fields of this region. Three varieties were used,—the narrow-leaved Okra type, the Willet Red, and a purebred strain of the Keenan variety. A plat of about half an acre was used, and the plants of each variety were arranged in the rows, thus: Red, Keenan, Okra, Keenan, Red, Keenan, Okra, Keenan, so that a Keenan plant always stood between an okra-leaved and a Willet Red plant. Only the narrowest-leaved plants of the Okra variety and the darkest red-purple plants of the Willet Red variety were used.

In the fall 1,290 bolls of the Keenan plants were separately picked and ginned. During the spring of 1909 the seed of each boll was planted in a hill by itself. As soon as the young plant had appeared above the ground, most hybrids of the Keenan × Red were at once apparent in the markedly red color of the stems together with the darker cotyledons of the young plants.[c] However, in the case of Keenan × Okra, it was learned that these plants could not be identified until they had grown large enough to show several leaves. It will be seen later that this fact somewhat interfered with determining the actual number of crossed bolls, since in many cases the crossed seedlings were destroyed by the chopping-out process before they had grown large enough to be identified. In case of the hills showing Keenan × Red crosses, however, a red plant was always left in the final chopping-out process, in order to examine these more carefully later in the season. After the final germination of all the seeds in each hill, it was interesting to note the actual number of crossed plants in each cross-pollinated boll. These ranged anywhere from a single Keenan × Red plant to every one from a boll producing 30 to 50

[c] Further observations have led the author to conclude that a red coloration in very young cotton seedlings does not always serve to distinguish at once the red-leaved variety or the Red-Green hybrids from the pure green-leaved varieties. In the red variety and its hybrids the intensity of the red coloration in the tiny seedlings shows considerable variation, and often times appears to develop as the plant increases in size and age. Even in the stems of very young seedlings of the green-leaved varieties a more or less distinct red color may become apparent, probably more noticeable when the planting season has been very cold and wet.

plants. In most instances, several Keenan ♀ × Red ♂ crosses were evident, but in a few cases every plant was red, showing that every ovule of these bolls had in some way been fertilized by pollen from Red plants.

APPROXIMATE NUMBER OF CROSSED BOLLS OBTAINED.

A tabulation of the crossed bolls is given below:

Results of an experiment to determine amount of natural crossing in a cotton field.

Row.	Keenan ♀ × Red ♂ crosses.	Keenan ♀ × Okra ♂ crosses.	Total of crosses.	Total bolls per row.	Per cent of crosses.
	Plants.	*Plants.*	*Plants.*		
1	27	3	30	170	17.6
2	21	4	25	179	13.9
3	28	5	33	175	18.8
4	22	5	27	177	15.2
5	28	10	38	147	25.8
6	20	8	28	146	19.1
7	28	6	34	134	25.3
8	31	6	37	119	31.0
9	6	2	8	43	18.6
	211	49	260	1290	20.+

It is at once evident that 20 per cent of the total number of bolls planted have been more or less completely crossed by natural pollinating agencies. It is evident, further, that a considerable number of the Keenan ♀ × Okra ♂ crosses must have been removed in the chopping-out process, since the seedlings were indistinguishable from the other plants at that period. It is not improbable that approximately 40 per cent or more of bolls would have shown crosses had Red plants been substituted for the Okra plants at the beginning of the experiment.

DIAGNOSTIC CHARACTERS OF THE HYBRIDS.

In connection with the experiment to determine the amount of natural crossing, it was thought advisable to obtain a number of artificial crosses of the Keenan ♀ × Red ♂ and Keenan ♀ × Okra ♂ to serve as checks in comparison with a study of the natural crosses. Of 95 plants from carefully hand-pollinated bolls of the Keenan ♀ × Red ♂ cross, every plant without exception showed the dominant red coloration of the Willet Red parent. From bolls of the Keenan ♀ ×

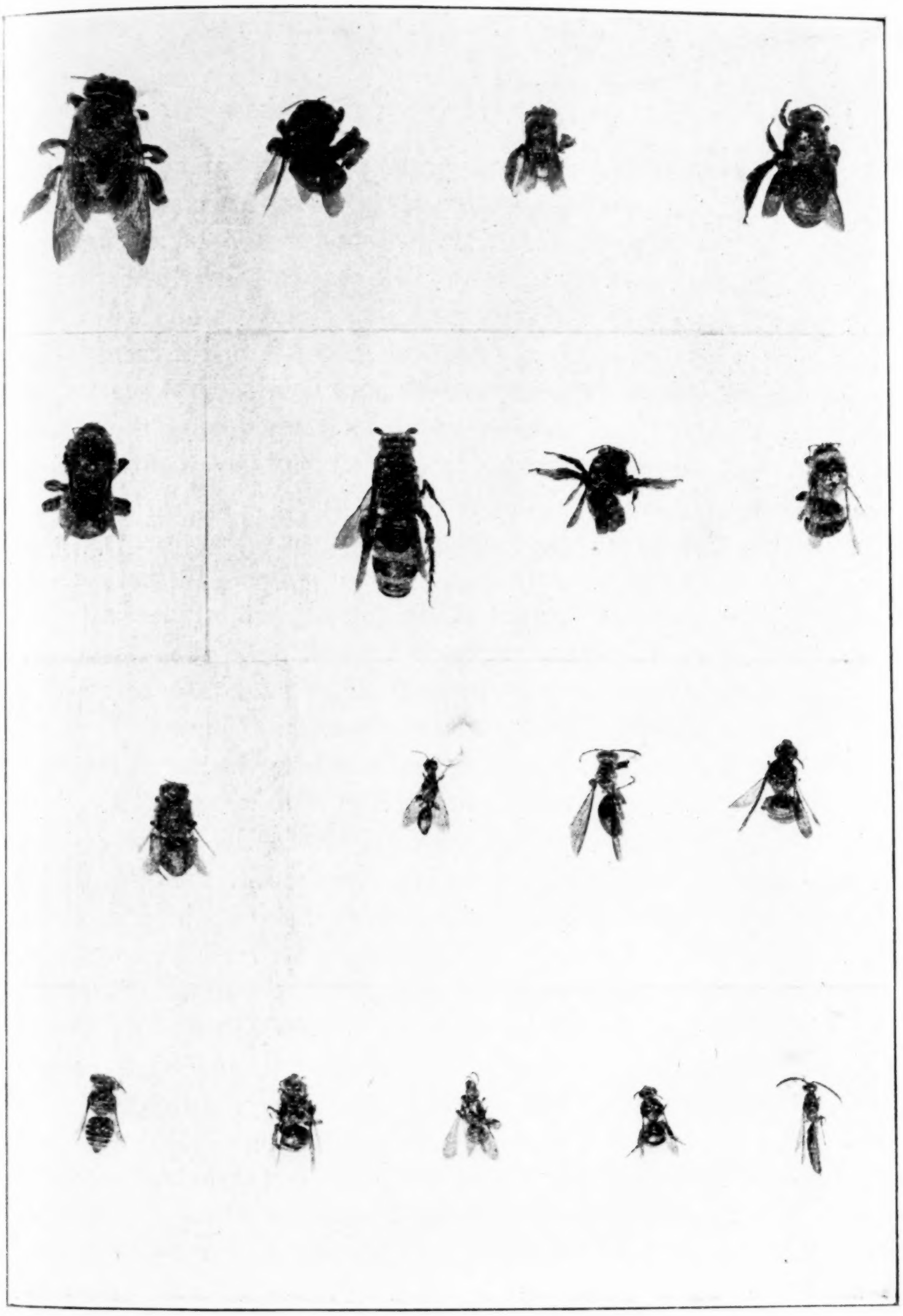
Okra ♂ cross, 84 plants were obtained, every one also showing the leaf-shape intermediate between the two parents. See the figure, page 248.

A careful study of the Keenan ♀ × Red ♂ hybrids revealed a number of diagnostic characters never found in the Keenan or any other pure strain of green-leaved upland variety. In the hybrids the general leaf coloration is several shades darker than the green-leaved Keenan—about intermediate between the two parents. Should this red coloration not be sufficiently marked, as may be the case in some instances, several other diagnostic characters serve to leave no doubt as to hybrid parentage. One of these is the nectary on the midrib of the under side of the leaves. This is always red, usually a deep red, as in the Willet Red parent. An examination of thousands of these nectaries of all green-leaved varieties has failed to reveal a single instance of this red color. Again, in the Red parent, and without exception in the hybrids, the deep red-purple color of the upper surfaces of the petioles, branches, etc., extends as a distinct collar or ring about one-half to three-quarters of an inch wide completely encircling the petiole at the juncture with the base of the lamina. In none of the green varieties has the writer been able to find this band of color completely encircling the leaf stem beneath.

The involucre in the Red plants and the Keenan ♀ × Red ♂ hybrids is always red, but much darker in the parent. In the green varieties the involucre is green, or only faintly tinged with red, rarely any noticeable coloration. The main stems, petioles, peduncles, and lateral branches are dark purple-red, almost black in the pure Willet Red plants, except the brighter under portions of the petioles and branches. In the hybrids the main stem and the upper surface of the branches and petioles are nearly if not quite as dark as in the parent Red. The under sides of the branches and petioles of the hybrids, however, almost entirely lack any red coloration, with the exception of the encircling red collar at the point of the union of the leaf with the petiole. This is about as dark as in the Willet Red parent.

In several respects the Keenan ♀ × Red ♂ hybrids are almost intermediate between the red and green parents, as in the general coloration of the leaf and involucre.

The nectaries of the midrib on the underside of the leaves and the red petiole collar are quite as dark red in the hybrids as in the Red parent.



SOME BEE VISITORS OF COTTON BLOSSOMS.

Top row, from left to right: *Elis plumipes*, Drury; *Melissodes bimaculata*, Le P.; *Bombus impatiens*, Harris; *Apis mellifica*, L.

2nd row, from left to right: *Xylocopa virginica*, Drury; *Melissodes caliginosus*, Cress; *Melissodes perplexa*, Cress; *Melissodes atripes*, Cress.

3rd row, from left to right: *Bombus scutellaris*, Drury; *Pristocera armifera*, Say; *Polistes americanus*, Fabr.; *Agapostemon splendens*, Le P.

Bottom row, from left to right: *Megachile brevis*, Say; *Entechnia taurea*, Say; *Agapostemon radiatus*, Say; *Augochlora pura*, Say; *Myzine hamata*, Say.

AGENCIES NATURALLY CROSSING COTTON BLOSSOMS IN THE FIELD.

Insects are the important natural pollinators of cotton blossoms. Among these, bees and certain species of wasps accomplish most of the work. The largest of the Hymenoptera is a handsome species of wasp (*Elis plumipes* Drury), which appears in the cotton fields of northern Georgia about August 1. The numbers of this insect and the earliness of its appearance vary greatly in different seasons. During the season of 1908 this insect appeared several weeks earlier in the season, and in far greater numbers, than during the season of 1909. In fact, during the season of 1909 I had given up seeing it at all. This wasp always visits the floral nectary at the base of the petals, and, owing to its large size and vigorous movements, succeeds in covering itself with great quantities of pollen. When present it is undoubtedly the most active pollinator of cotton blossoms in the fields. A few of the most common members of the Hymenoptera regularly concerned with cross-pollination are *Melissodes bimaculata* Le P., *Apis mellifica* L., and *Bombus impatiens* Harris.

The bee *Melissodes bimaculata* and the honeybee are probably the mose abundant and constant visitors of cotton, more especially the former. This bee is extremely common in northern Georgia every season and at all times. It is the earliest bee to squeeze into the opening but at break of day; and it probably visits every blossom in a cotton field at some time during the day. So far as the writer's observations go, this bee visits only the true floral nectaries, so that at all times it is a most efficient disseminator of extraneous pollen into other blossoms.

Other Hymenoptera may frequently be found visiting cotton blossoms, but, owing to their smaller size, rarity or irregular visits, these are not especially important as pollinators. However, every additional insect visitor of cotton blossoms increases the chances of more or less crossing. The following is a list of all the Hymenoptera[a] and beetles which have been taken by the writer in cotton blossoms during the last two years:

HYMENOPTERA.

Bombus scutellaris. Drury.
Entechnia taurea. Say.
Xylocopa virginica. Drury.
Melissodes atripes. Cress.
Agapostemon splendens. Le P.
Agapostemon radiatus. Say.
Dianthidium interruptum. Say.
Myzine hamata. Say.

[a] The writer is indebted to Mr. H. L. Viereck, of the U. S. National Museum, for the identification of all the Hymenoptera listed in this paper.

HYMENOPTERA—CONTINUED.

Melissodes caliginosus. Cress.
Melissodes perplexa. Cress.
Melissodes bimaculata. Le P.
Xenoglossa pruinosa. Say.
Polistes americanus. Fabr.
Anopolius subviolaceus. Cress.
Megachile brevis. Say.
Augochlora pura. Say.
Halictus ligatus. Say.
Pristocera armifera. Say.
Elis plumipes. Drury.
Bombus impatiens. Harris
Bombus scutellaris. Drury.
Apis mellifica. L.
Ceratina dupla. Say.
Sceliphron cementarius. Drury.
Halictus (chloralictus) pilosus. Smith.
Halictus (augochlora) similis. Rob.

BEETLES.

Hippodamia convergens. Guer.
Tetraonyx quadri-maculata. Fab.
Epicauta trichrus. Pall.
Megilla maculata. DeG.
Diabrotica vittata. Fab.
Systena taeniata. Say.
Phalacrus simplex. Le C.

In northern Georgia region cotton blossoms are rarely visited by any of the Lepidoptera. The writer has observed but one individual butterfly (*Basilarchia astyanax* F.) visiting them. So far as cross-pollination is concerned, these need almost no consideration.

Balls,[e] in Egypt, states that "the extra involucral glands are visited by Lepidoptera." These visitors, however, could in no way effect cross-pollination. A number of other insects may be found casually visiting cotton blossoms, namely, some of the bugs, a number of tiny flies, leaf hoppers, beetles, and ants. In Egypt Balls finds that ants are the chief visitors of the true floral nectaries. Although any of these insects may occasionally transfer some pollen from one blossom to another, since pollen grains can be detected on their bodies, yet, except where it is desirable to exclude every chance of crossing, these smaller insects may be neglected.

Humming birds are regular and persistent visitors of cotton blossoms. The writer has frequently watched three or four at work at the same time and heard their sharp click-click-click as they darted from flower to flower. These birds rarely, so far as the writer has observed, enter the blossoms from above, but thrust their long, slender bills down between the involucral divisions and the petal claws in order to reach the inner involucral and floral nectaries. In this approach to the blossom there is little chance for them to transfer any pollen to the pistils of other blossoms. These diminutive birds are frequent

[e] "Notes on Heredity in Cotton," Year Book of the Khedivial Agricultural Society, 1906, page 68.

visitors of cotton fields and may often be seen fighting fiercely with each other, their tiny rapier-like bills striking the adversary very audibly, with a noise as if striking sharply on silk.

The writer believes that wind can transfer considerable pollen about cotton fields, and, where strict scientific accuracy is expected, this agency must be guarded against. In the heat of the day, when the anther sacs have fully opened and the pollen has become dried and dust-like, it is a simple matter to invert a cotton blossom, and produce a visible cloud of pollen. In fact, late in the afternoon an examination of the hairy leaf surfaces, etc., reveals an enormous amount of pollen scattered about. A vast amount of this pollen has been brought out of the blossoms by bees and fanned and scattered about in their flights from plant to plant. Nevertheless, it is in position to be further disseminated by every breeze that blows. The writer further tested this point by placing between the cotton rows several exposed and developed photographic plates, coated with the thinnest film of vaseline to retain any pollen which might fall upon them. The dark color of these plates readily revealed any of the yellow pollen. This was done for several days, and in every instance more or less pollen in considerable masses was caught. Bees in their flights and winds alone can account for the presence of this pollen. These tests were made at a time when very little wind was stirring. On bright, windy days the quantity of pollen flying about must be considerable. This would be especially true of the best fields producing tall long-limbed plants easily whisked about by winds. In such fields the interlocking branches, by bringing the different blossoms more closely together, very much favor chances of occasional wind-pollination. Wind-pollination, however, would necessarily play a very minor part, as the period most favoring it follows some hours later than the period of most active and thorough pollination by bees.

COURSE OF BEES AMONG THE COTTON PLANTS.

Whether or not insects are active pollinators of cotton depends much upon the way the blossoms are visited. The cotton blossom is amply furnished with several sets of nectaries, from the inside to the outside. In many instances the outer and inner involucral nectaries only are visited. Such visits can effect no pollination of the pistils. Honeybees are among the most frequent visitors of cotton blossoms, but, at the same time, they are very generally visitors of the outer

involucral nectaries alone.[1] Bumblebees and many others rarely visit these, but enter the flowers to visit the floral nectaries, and become loaded with pollen, oftentimes so they cannot fly. It is not uncommon to see one of these bees almost helpless on a leaf or flower, from the great quantity of pollen adhering to its wings, head, and legs. Nearly all bee visitors show a marked tendency to pass from plant to plant up and down the rows rather than across. Under date of August 4, 1908, observations of the following bees in fields at Thompson's Mills, Georgia, more clearly bring out this fact:

Bee 1. A species of bumblebee, visits the blossoms of the Asiatic Hawasaki variety. It visits the inner involucral nectaries almost entirely, as in this cotton the outer nectaries are wanting. It visits alike open blossoms, buds ready to open in a day or two, and squares with young bolls already set. It visits 6 plants successively in one row, then flies elsewhere.

Bee 2. A honeybee, visits 9 plants in one row in succession, then retraces 21 consecutive plants to the end of the row. The outer involucral nectaries almost the only parts visited.

Bee 3. Honeybee, visits 2 plants in one row, then 4 plants in the next row, then flies elsewhere.

Bee 4. Honeybee, visits 4 plants in one row, then flies away.

Bee 5. Honeybee, visits 6 plants successively in one row, then 1 plant in the next row, and again 1 plant in the next.

Bee 6. Honeybee, visits 10 plants in succession, then 8 in the next row, then 6 in the first row again, then 6 in the second row, finally flying away.

Bee 7. Honeybee, visits 15 consecutive plants in one row, then flies off.

Bee 8. Honeybee, visits 11 consecutive plants in one row, then flies away.

Bee 9. Honeybee, visits 6 consecutive plants in one row, then retraces 4 and flies off.

Bee 10. Bumblebee, visits 5 consecutive plants and flies away.

Bee 11. Honeybee, visits 6 consecutive plants, then 3 in the next row, then 3 back in the first row, then 2 in another row, and flies away.

Bee 12. Honeybee, visits 6 in one row, then 6 in the next row (outer involucral nectaries only).

Bee 13. Honeybee, visits 6 plants in one row, then 6 in next row (outer involucral nectaries only).

Bee 14. Honeybee, visits 4 plants in one row, then 2 in the next row, and flies off.

[1] Of many hundreds of bee visitors observed in their visits to cotton blossoms at the beginning of the blossoming season of 1910, rarely did a bee visit any other portion of the flower than the inside. Considerably later, however, when blossoms were exceedingly abundant many bees regularly visited the outer involucral nectaries, especially the common honeybee. This change in the manner of visiting cotton blossoms may follow some change in the relative quantity or quality of nectar in the outer involucral and inner floral nectaries, or it may as likely be due to an awakened memory-impulse which directs the bees to the outer nectaries once these have been discovered.

These casual records are sufficient to show the enormous number of blossoms a single bee is capable of visiting in a few hours, and the probabilities of intercrossing a great number of these all over the field.

The process of cross-pollination of the blossoms by bees is accomplished most readily during the early morning hours. Following clear, hot nights, the petals begin to unfold very early, and by daybreak an aperture has opened sufficiently to allow the bees to squeeze through. At this time of day the anther-sacs have hardly opened, and the pollen is so moist and adhesive that the chances are much in favor of a visiting bee introducing foreign pollen before self-pollination has taken place to any extent. Again, owing to the narrow passageway between the slightly unfolded petals, a bee is compelled to move almost directly in contact with the protruding stigmatic surface of the pistil, in order to get at the pollen or nectar beyond, thus insuring the chances of introducing more or less external pollen directly upon the receptive stigma. Almost before day, bees are forcing their way into the expanding buds, and an examination of these reveals many whose stigmas have been pollinated long before the flowers are fully opened.

EXTENT OF CROSSING IN DIFFERENT LOCALITIES.

It is very probable that the percentage of cross-pollinated cotton blossoms, accurately determined for different seasons and for different localities, would show wide variation. This is necessarily true, since the amount of crossing depends very largely upon the number of bees and the kinds in any particular locality. Not all bees are active pollinators, and at different seasons the relative numbers of the different species are greatly variable. The writer has mentioned the variable occurrence in northern Georgia cotton fields of that active pollinator of cotton, the wasp (*Elis plumipes* Drury). Cook, in Arizona, finds a marked difference in the kinds and relative numbers of the bees in different localities of Arizona. The writer has observed that in the near vicinity of domestic hives in northern Georgia the number of honeybee visitors is enormously increased.

WHEN NATURAL CROSSING MUST BE EXCLUDED.

Many lines of cotton-breeding work require that all chances of cross fertilization must be eliminated. This is especially true where problems of Mendelian interest are studied. Where strictly scientific

results are expected along certain lines of heredity, or where it is intended to determine the specific effects of soil, climate, and fertilizers upon the oil and nitrogen content of cotton seed, as in investigations now in progress, one of the first requisites must be to prevent any free crossing. A number of methods are followed toward this end. One has been to enclose the mature individual blossoms just before opening in small paper bags until self-fertilization has taken place. Another method quite as difficult and far more expensive has been to enclose the entire individual plant in a meter-square mosquito net. Although mosquito netting does effectually exclude all the larger insects, it is not a certain safeguard against the introduction of pollen by the very small insects, such as ants, or by air currents. Balls, in Egypt, in a recent letter to the writer, brings this out very forcibly in the following words: "I don't mind confessing that I can't stop vicinism, so that there must be some mighty prepotent pollen knocking about a breeding plat when it can't be excluded by a meter-square mosquito net, and flowers under the same which do not show any sign of the presence of a style in side view of the column." It will be seen, then, that carefully bagging the individual blossoms, although a tedious operation, is the only sure way of preventing intercrossing.

With regard to the prepotency of pollen of different varieties, the writer's own experiments do not as yet indicate any definite results in that direction. It appears that any and all pollen stands an equal show in the fertilization of the ovules. A study of the Red plants occurring in the naturally crossed bolls of the experiment previously mentioned seemed to indicate that the number of hybrid Reds, in any boll, was dependent only upon the number of pollen grains transferred from the Red variety. In those hills showing only a single Red plant, and there were a number of these, it can only be concluded that a single pollen grain reached the stigma in time to fertilize a single ovule.

In 1908 the writer carefully hand-pollinated a number of Keenan flowers, after emasculation, with pollen both from a Red plant and from a Keenan plant. During the chopping-out process the Red plants were given preference to remain. The following results were secured:

Boll 1—Keenan ♀ × Red ♂ and Keenan ♂. Eleven plants remained, of which 7 were red and 4 white.

Boll 2—Keenan ♀ × Red ♂ and Keenan ♂. Eleven plants remained, of which 9 were red and 2 white.

EFFECT OF UNCHECKED NATURAL CROSSING IN THE FIELD.

In all fields of unselected cotton, there is an intermingling of many types, both desirable and undesirable. Among the worthless types are the low-linted and lintless plants, plants of low inherent productiveness, extremely small-bolled plants, and plants of weak resistance in the presence of disease. Where extensive crossing is allowed to take place under these conditions, it is evident that the presence of all these worthless types must soon result in contaminating the blood, so to speak, of all superior plants by intercrossing with them. Following this, any attempt at selection for specific lines of improvement would be rendered slow and uncertain until purity of type had again been established. The writer, within the past few years, has found just such conditions to prevail in some of the best cultivated fields of northern Georgia. In one unselected field in particular the lintless type of plant was not uncommon. This type of plant, if inbred, retains its lintless characteristics very uniformly. However, in studying the progenies of selections from this field of the most promising plants the writer has ever seen, the appearance of decidedly lintless individuals from those supposedly superior parents indicated a line of heredity resulting from a union of the best and poorest plants by natural crossing in the past.

In fields of carefully bred and selected cotton, on the other hand, intercrossing is probably a beneficial process. As a result of a more or less complete blending of parental characters in the complicated processes of inheritance, a start made with a number of pure, superior, and uniform types followed by intercrossing must tend to bind very closely within the hereditary mechanism of the future plants the original parental characteristics. Promiscuous natural crossing is undoubtedly one of the most potent factors producing variability in a cotton field. A vast amount of the so-called inexplicable fortuitous variation is without doubt traceable to this cause.[9]

A plant that appears to be a mutant may have resulted from some new complexity of parentage induced by intercrossing. Why should not endless readjustments of the hereditary forces tend to produce exceptional plants far more surely than by any process of pure mutation? The writer feels that this very phase of natural crossing is a

[9] A number of very promising distinct long staple types which have been grown several years in the experimental fields in Georgia surrounded by varieties and hybrids of all sorts have finally become, through natural crossing, almost hopelessly swamped with hybrid types of every conceivable sort.

most important basis for further improvement in cotton. What led to the origination of the striking Columbia variety? Was it the result of what we term mutation forces, or was it due to some interchange of the hereditary units? One of the most promising upland long-staple strains the writer has ever seen gives strong evidence of a cross in the past.

One of the most important conclusions, however, derived from the results of more or less extensive intercrossing in cotton, is that it is vitally necessary to practice careful and persistent seed-selection to prevent deterioration. In those cotton-growing regions where it is proven that the frequency of natural crossing is as great as 10 per cent or more, as is highly probable in northern Georgia, there is no more potent or convincing evidence needed in support of the advisability of careful seed-selection.

SUMMARY.

Natural crossing in cotton has been a factor much neglected by most cotton growers and breeders in the past.

In cotton fields of northern Georgia the demonstrated proportion of crossed blossoms is at least 20 per cent, with strong probabilities that approximately 40 per cent of the blossoms are crossed.

Although crossing may be very detrimental in unselected cotton, in selected cotton it is probably beneficial.

The factor of cross-pollination should be one of the most direct and potent facts in support of careful seed-selection.

[Presented by Committee on Breeding Cotton.]

BREEDING TO IMPROVE PHYSICAL QUALITIES OF TIMBER.

GEORGE L. CLOTHIER, *Agricultural College, Mississippi.*

Plant breeders have not yet devoted much attention to the breeding of forest trees or to systematic attempts to improve the physical qualities of timber. That there is a great field for such work is the opinion of the writer, and the purpose of this paper is to stimulate the foresters of our country to efforts along this line. Every woodsman is familiar with the fact that individual trees of the same species and size vary greatly in the amount of heartwood, straightness of grain, strength,

durability, weight, elasticity and other qualities of wood. It is quite probable that many if not all the physical qualities of timber are transmissible from generation to generation by heredity. Experiments have been made by Prof. J. W. Tourney, of Yale Forest School, that seem to indicate that seedlings from mother trees of *Pinus ponderosa* with twisted grain show a decided twist of the fibers from the time of germination. If defective seed trees leave their defects impressed upon their offspring, it behooves the foresters to reverse the time-honored policy of leaving only unmerchantable trees to bear seed.

Woodsmen recognize two kinds of timber from a number of our common species according to the intensity of the color of the heartwood. Such, for example, is the case when they speak of white and yellow poplar, white and red gum, white and yellow cedar, etc. In fact the intensity of the color of wood has been taken by some writers to indicate the durability of the wood, and hence to give an index to its value. For woods from the same species, the rule holds good that the more deeply colored heartwood, where not attacked by disease germs, is more resistant to decay; but it is not safe to extend this generalization to a comparison of different species. For example, the timber from many of the white cedars lasts three or four times as long as the darker-colored red cedar; and California redwood, a pinkish-colored wood, will last several times as long as our very dark-colored black walnut. Intensity of color simply indicates a great quantity of the preservative material naturally produced by the species in question for the preservation of its own heartwood. These preservatives differ in their antiseptic qualities, according to the species producing them, and also differ in color, but darkness of color is no indication of their antiseptic power.

Breeders of forest trees can ascertain the quantity of preservative materials in the heartwood of any definite mother tree and the depth of the sapwood by the use of an instrument like "Pressler's increment borer," which extracts a small core from the bark toward the center of the tree without injury to the tree; and they can know by this means definitely whether the tree examined possesses the qualities of heartwood desired in its offspring. According to the use to which the wood is to be put, it may be desirable to have as little heartwood as possible or *vice versa.* Almost all imaginable differences in quantity and quality of heartwood of the same species will no doubt be found to exist when foresters attack this problem in a practical way.

Strength is a physical quality of wood that varies in the same species several hundred per cent. The microscope will often reveal what the timber-testing machine conclusively proves to be the condition of the woody tissues in a piece of timber. Unfortunately, the testing machine cannot be applied to the wood of living trees, but small fragments may be removed from a standing tree for microscopic study without endangering the life of the tree. The microscopic structure of wood gives a clue to its strength and other valuable qualities, and hence the timber breeder of the future will no doubt have a laboratory equipped with microscopes and accessories for the study of the cellular structure of his trees. It is a well-known fact that the stiffness of a piece of wood is dependent upon the thickness of its cell walls and that resistance across the grain to destructive rupture depends to a great degree upon uniformity in size of the cells. Wood having great tensile strength is made of long cell fibers, while wood with great elasticity usually has very uniformly fine grain.

The user of wood determines what physical qualities are technically most important, the timber tester determines the measure of these qualities, and it remains for the breeder to intensify or improve these qualities. While it takes many years of experiment to determine how far a definite quality in a forest tree is transmissible by heredity, the evidence that the physical qualities of timber are hereditary is sufficiently strong to warrant foresters in making some efforts to select their seed trees along this line. Since the majority of the desirable qualities can be identified by the unaided eye of the close observer, it would seem that there is no valid reason why foresters should continue to ignore such a promising field.

REPORT OF COMMITTEE ON BREEDING FISH.

JOHN W. TITCOMB, *Lyndonville, Vermont.*

Experiments in reference to the hybridization or crossing of allied species have been continued at several stations of the United States Bureau of Fisheries. While the results have almost invariably been disappointing, it may be of future interest to record some of them.

Some hybridization experiments of the United States Bureau of Fisheries during the years 1907-1909.

Name of station.	Parents.[a]		Results.
	Male.	Female.	
Nashua, N. H.....	Brook trout.....	Sunapee saibling...	Procreative hybrids.
White Sulphur, W. Va...	Rainbow trout....	Brook trout.....	Imperfect embryos; no hatch.
Do.....	Brook trout.....	Rainbow trout....	Perfectly formed young fish, but weak.
Leadville, Colo.....	Loch Leven trout..	Brook trout.....	Small percentage of young fish.
Do.....	Brook trout.....	Loch Leven trout..	Small percentage of young fish.
Do.....	Brook trout.....	Rainbow trout....	Normal hatch, but accidentally mixed with other fish.
Do.....	Rainbow trout....	Loch Leven trout..	"Glassy" eggs; no hatch.
Do.....	Black Spotted trout	Rainbow trout....	Normal young fish still under observation.
Craig Brook, Me.[b].....	Humpback salmon.	Silver salmon.....	Good hatch followed by abnormal death rate and deformity of tail in survivors.
Do.....	Humpback salmon.	Sockeye salmon...	Good hatch; after year 75% loss; rapid growth among survivors.
Do.....	Sockeye salmon...	Blue Back salmon.	Fair hatch; small number survived; rapid growth among survivors.
Do.....	Dog salmon.....	Humpback salmon.	Died soon after hatching.
Do.....	Chinook salmon...	Silver salmon.....	3% hatched.

Some of the above experiments have not been carried far enough to determine whether the hybrids are procreative. None of them have produced a hybrid superior to either of their progenitors. Of the Pacific salmon hybrids, the two showing rapid growth encourage a continuation of the observations until it has been determined whether they will mature and reproduce. The salmons all show a remarkable susceptibility to the throat tumor disease.

[a] Brook trout, *S. fontinalis;* Sunapee saibling, *S. aureolus;* Rainbow trout, probably *S. irideus;* Loch Leven trout, *S. trutta levenensis;* Black Spotted trout, one of the native trouts of the Rocky Mountains.

[b] The Pacific salmon hybrids hatched at Craig Brook, Me., were from eggs obtained on tributaries of the Skagit River, State of Washington.

A great many similar experiments in hybridization have been conducted in the United States of which the observations have not been carried far enough or the results did not warrant it.

Experiments in the crossing and hybridizing of various species of salmonidæ have been made in Scotland and several European countries. Both the Rainbow and the eastern Brook trouts of America have been crossed with the European trouts at various fish-culture establishments. Impregnation is readily accomplished, but in all the efforts to hybridize the trouts and salmon of Europe, as well as in the crossing of American with European species of trouts, it appears to be regarded as established that, while there is a development, it soon reaches its end or leads to malformations. Some of the hybrids are procreative, but in general the results have been disappointing, and foreign fish culturists appear to have discontinued breeding experiments of this character.

It seems useless to continue the experiments until an experiment station has been established where hybridization and other experiments can be systematically conducted under scientific observation and carried to a definite conclusion.

The experiment inaugurated at the Northville station in selecting and breeding for specific bacterial immunity in Brook trout has resulted in failure, the 20,000 fish held for the purpose having succumbed to the disease.

The committee is not entirely discouraged by the failures here reported, but is unanimous in the opinion that few if any satisfactory results can be obtained until one or more experiment stations have been established at which the work can be conducted unhampered by the regular fish-cultural work that is the necessary and legitimate work of the existing State and Federal hatcheries.

The necessity for experiment stations to advance strictly fish-cultural work is quite as important as for experiments in breeding. However, fish culture and fish breeding are so interdependent that one experiment station could be utilized in the advancement of both.

A PHEASANT-BANTAM HYBRID.

H. J. Wheeler, *Kingston, R. I.*

Although there have been reported, from time to time, several instances of a successful cross between the pheasant and the domestic fowl, none of these has thus far withstood the results of close investigation. The following is a brief description of the results of an actual cross secured by Dr. Leon J. Cole at the Rhode Island Agricultural Experiment Station in the spring of 1908.

Of 77 eggs of the bantam fowl laid between March 23, 1908, and August 27, 1909, only one was fertile. This egg was laid March 30, 1908. It was set under a hen on April 4, and hatched April 28, thus giving an incubation period of 24 days.

DESCRIPTION OF THE FATHER.

This bird, a Ring-Neck pheasant, was of average size, plumage, and vigor. The feathers of the head and neck were irridescent and purplish, with a greenish cast upon the top of the head. The short feathers of the face patch were turkey-red. The measurements of the different parts of the body were as follows:

	Millimeters.
Length of upper mandible	27
Width of mandible at base	20
Ear tufts	15
Length of wing	250
Length of tail	540
Length of tarsus	70
Length of middle toe	58

Weight, 2 pounds, 10 ounces.

The color of the eye was bright bay.

DESCRIPTION OF THE MOTHER.

The mother of the hybrid was a mongrel bantam. The general color was buff with faint black stripes on the neck. A large amount of black appeared in the primary wing feathers and in the inner veins of the secondaries. The tail feathers were largely black, but contained some yellow. The comb was low, but had the rose-comb characteristics, and possessed a prominent spike. The wattles and ear-lobes were very well developed. The measurements of different parts of the body were as follows:

	Millimeters.
Length of upper mandible	18
Width of mandible at base	13
Length of tarsus	58
Length of middle toe	54

Weight, 1 pound, 14 ounces.

The color of the eye was a faded yellow.

DESCRIPTION OF THE HYBRID.

The color of the head and neck was dark because of the presence of much black in the feathers. The yellow, however, showed through to a considerable extent, especially on the top of the head, on the forehead, and on the upper throat region. The space immediately surrounding the eye was red. A slightly purplish irridescence appeared on the feathers of the lower neck. The general color of the body and back was a mixture of light yellow, darker yellow, chestnut, and also black, in very irregular patterns. In many instances the black formed a double stripe on the feathers, while the chestnut was usually present on the edge of the feather and formed a band. The feathers of the rump and the tail coverts had many small black specks. The flights were a mixture of black and light yellow. The primaries were darker at the distal end. The tail feathers had an appearance more like the primaries. The comb was very low, having somewhat the appearance of a rose comb, but without the spike. The wattles and ear-lobes were absent. The eye had a yellowish tinge between faded yellow and a bay color. The measurements of various parts of the body were as follows:

	Millimeters.
Length of upper mandible	26
Width of mandible at base	18
Length of the wing	224
Longest tail feather	213
Length of tarsus	70
Length of middle toe	65

Weight, 3 pounds, 3 ounces.

For the first few weeks of its life, this hybrid more nearly approached pheasant chicks (Ring-Necks) in both color and call. When the feathers began to come, however, the bird lost some of its resemblance to pheasant youngsters and also ceased its call except when frightened. The bird was kept carefully cooped to avoid its destruction by vermin. In spite of being fed and watered three or four times daily,

it grew and remained very wild; two ducklings were put into the coop, but they seemed to exert no taming effect. After several months, it was transferred to a turkey yard in which were its parents, pigeons, and turkeys. Very soon, the hybrid became much more domesticated. As an adult, nothing has been observed in its behavior to indicate sex; its call (only when frightened) is of a higher note than the cock pheasant's and is somewhat like that of a cornered rat.

COMPARISON OF THE PHEASANT, BANTAM, AND HYBRID.

The general shape of the head of the hybrid was much more like that of the pheasant. It lacked, however, the velvety feathers on the face, and did not have the extension into the ear-lobes, which was prominent on the pheasant. The bill of the hybrid was shaped somewhat like that of the pheasant, but was rather lighter in color. It was also more grayish in appearance than that of the bantam. The general color of the body plumage resembled more closely that of the pheasant, except that the markings of the hybrid were not so regular, and more of the light yellow of the mother was apparent. The shape of the wing resembled more closely that of the bantam, but it was considerably longer. It did not, moreover, show the peculiar color and definite bars characteristic of the tail of the pheasant. The longest feathers of the tail were broad and rounded at the tip. They were much less long and tapering than those of the pheasant. They were carried, moreover, in a more erect position, showing no tendency to trail as did those of the father. The reason for this obviously lies in the anatomical structure of the tail-bearing portion, which resembles more closely that of the bantam. While in the pheasant the legs and feet were quite dark, and in the bantam a faded yellow color, in the hybrid the color was between these two. Furthermore, while the pheasant had well developed spurs, about 10 mm. in length, and the bantam very short spurs on both feet, the hybrid had on the right foot a short blunt spur and on the left only a low wart-like structure. When the hybrid was compared with the pheasant hen, it was obvious that the color-resemblance to the female pheasant was more striking than to the male bird, but that the form-resemblance to the female was less marked.

[Presented by Committee on Breeding Wild Birds.]

PROGRESS IN THE PROPAGATION OF SEEDLINGS OF SUGAR CANE IN LOUISIANA.

HAMILTON P. AGEE.

There was presented at the 1907 meeting of the American Breeders Association, by Dr. C. O. Townsend, a paper on "The Improvement of Sugar Cane by Selecting and Breeding," which summarized in a complete manner the work of various investigators who have endeavored, since the discovery of the fertility of the seed of the cane, to propagate better varieties of this important sugar-producing plant.

A report from the Louisiana Sugar Experiment Station in 1908 told how it was long thought that this work must be confined to the Tropics, where cane seed could be secured in a fresh state for germination and be handled under the most favorable conditions of temperature. It seemed that Louisiana must depend on securing her varieties of cane from those countries where summer heat continued throughout the year; for, although the semi-tropical conditions of the southern part of that Stat are such as to permit of a profitable cane-sugar industry, nevertheless the curtailment of the growing season by the cool weather of the winter months prevents that stage of maturity which is necessary for the production of the seed-bearing arrows or tassels. This confronted Louisiana with an additional handicap in her competition against other cane-growing countries. Not only was an industry to be maintained by the growth of a tropical plant without its natural habitat, but the possibility of the propagation within her bounds of new varieties of this plant, which would thereby more likely become acclimated to her conditions, appeared to be withheld. The continuance of the sugar industry in Louisiana through its various periods of adversity may be attributed to a stroke of extreme good fortune in the introduction, as early as 1820, while the industry was yet in its infancy, of a cane which by sheer chance was one of the few varieties that can be grown with profit at a latitude of 30 degrees north.

That cane culture in the State had grown to be a thriving industry by one chance in hundreds was not fully realized until after the Louisiana Sugar Experiment Station (established in 1885) had collected from the various sugar countries throughout the world those varieties which produced the maximum returns in foreign lands noted for their large yields, and found them without exception under semi-

tropical environments to be inferior to the cane which had been grown in Louisiana since 1820.

After the inauguration of seedling work in the Tropics, the Louisiana interests received great benefit from the introduction of the two Demerara seedlings which proved to be superior to canes then grown in the State. It was well known for a long period of years that the possibilities of securing better varieties would be considerably enhanced by germinating seed in large quantities under the prevailing conditions of the section where they were to be utilized and selecting from the great numbers the few that might prove to be superior to the varieties grown on the plantations. It was not, however, until a few years ago that the proper means of handling this delicate branch of nursery work was found. Since it was Mr. A. E. Weller who was in active charge of this undertaking, he should be recorded as being the first, and, up to the present time, the only one who has succeeded in securing the germination of sugar-cane seed at a latitude without the bounds of the Tropics. His success in this work is all the more deserving of credit since it followed a series of failures by others since 1890.

The methods and the scheme of handling these seeds and the tender seedlings produced therefrom were described in the report, with an account of the work to that date. It only remains therefore to give information on the continuance of this endeavor to secure better varieties of cane for the Louisiana planters, and to point out the encouraging features which have presented themselves.

In preparing for the seedling work of the current year, letters were addressed to various government agricultural departments, experiment stations, botanical gardens, sugar companies, and individuals, throughout the girth of the globe, requesting cane seed for the work in hand. The writer is extremely grateful to those who contributed, for without this assistance the work would be impossible. A list of those who thus cooperated is given as follows, showing the wide range of sugar-producing countries from which the seed were secured and the different varieties of cane from which they came, and also the number of germinations secured from each variety:

Contributions of sugar-cane seed.

Contributor.	Country.	Varieties from which seed were furnished.	Number of seedlings secured.
Francis Watts, Government Chemist and Superintendent of Agriculture	Antigua, British West Indies	D. 1640	None
		D. 116	None
		D. 95	None
		D. 109	None
		Sealy Seedling	None
		Red Ribbon	None
		White Transparent	None
		Queensland Creole	None
J. C. Waldron	Antigua, British West Indies	D. 95	5
		D. 109	194
		B. 147	77
		B. 306	1
		B. 208	None
		B. 1355	2
		No number	1
Noell Deerr, Acting Director Sugar Experiment Station	Honolulu, Hawaii	Lahaina	None
		White Tanna	None
		Hawaii No. 8	None
		Hawaii 355	None
		Hawaii 400	None
		Hawaii 403	None
		Hawaii 404	None
		Hawaii 5584*a*	None
		Hawaii 5586*a*	None
		Hawaii 5592*a*	None
		Hawaii 5596*a*	None
		Hawaii 5615*a*	2
		Hawaii 5621*a*	None
D.W. May, Special Agent in Charge Experiment Station	Mayaguez, Porto Rico	T. 77	1
		D. 74	1
J. T. Crawley, Director Estacion Central Agronomica	Santiago de las Vegas, Cuba	Crystallina	None
		Pappoa	None
		D. 108	None
		P. 77	None
		D. 74	None
		T. 211	None
		B. 6450	None
John R. Bovell, Superintendent Department of Agriculture	Bridgetown, Barbados, British West Indies	B. 208	3
		B. 3390	None
		B. 3405	None
		B. 3412	2
		B. 3696	None
		B. 3922	None
		B. 6171	None
F. Evans, Acting Superintendent Botanical Department	Port-of-Spain, Trinidad	T. 209	None

[a] Hybrids.

Contributions of sugar-cane seed—Continued.

Contributor.	Country.	Varieties from which seed were furnished.	Number of seedlings secured.
Robert M. Grey, Harvard Botanical Station[b]	Cienfuegos, Cuba	Cinta (Red Ribbon)	None
		Harvard No. 73	24
		Harvard No. 219	None
		Harvard No. 88	None
		White Sport	None
		Crystallina	None
Department of Agriculture[b]	Jamaica, British West Indies	D. 95	None
		D. 115	1
Department of Agriculture[b]	Trinidad, British West Indies	T. 209	None
Director Treub[b]	Buitenzorg, Java	G. Z. No. 247	None
Colonial Sugar Refining Company, Limited[b]	Sydney, New South Wales	Badila	1
		Mobona	None
		H. Q. 10	None
		H. Q. 50	None
		Couve 87	7
		Striped Singapore	None
		Rose Bamboo	None

It is interesting to note the large number of germinations from the seed sent by Mr. J. C. Waldron of Antigua. This is the more remarkable because the opinion has been expressed by scientific investigators in Antigua that the cane arrows of that island do not bear fertile seed. The greater success of the Louisiana work on these seed than on those from elsewhere may be due to the fact that they were shipped in large bundles, which kept them in a better condition than those which were sent in small packages by mail. It is thought likely, however, that Mr. Waldron exercised good judgment in selecting tassels which were in prime condition for gathering.

Gratification is felt in securing eight germinations from the seed from Australia, as it is shown that the shipment of the delicate seed from such a great distance does not of necessity destroy its vitality, as has been heretofore supposed.

As was explained in the report of last year, canes obtained from each germination are classed as different varieties and receive a number which is prefixed by a letter indicating the country in which they originated. The entire amount is then planted out and the succeeding

[b] Received through Mr. David Fairchild, Agricultural Explorer in Charge, Bureau of Plant Industry, U. S. Department of Agriculture.

year a sufficient quantity is obtained to make a laboratory test of the juice and to plant an area large enough to furnish data the following year that will be indicative of the sugar-producing value of the juice and the tonnage yield per acre.

Unfortunately, the date of the meeting (Nov. 15, 1909) does not permit of a detailed report of the laboratory and field tests of this year, as this is at present in an incompleted stage.

The conclusions drawn from the work, so far as it has gone, give nothing of a phenomenal nature to report. However, the results are of such a satisfactory nature that promise is had that this Louisiana seedling work will ultimately prove of the greatest commercial value to the sugar interests of the State. If in the course of the next decade it is possible to originate a variety which has inherent properties that will cause it to yield a 10 per cent greater sugar return per acre than is had from the varieties now cultivated, it can be readily understood how great a money value will accrue from these investigations.

A disappointment is had in this year's results from the L92, which last year gave richer juices than the celebrated D74. There are four of the new varieties—L201, L248, L450, L511—propagated in 1908 (on which laboratory tests were made for the first time this year) that were superior in sugar content to the D74 on October 15. Data as to tonnage may offset this advantage, and, furthermore, the canes may retrograde another year, as was the case with the L92. But, be this as it may, the results have pointed out that what once seemed possibilities of ultimate success are now closely verging upon the probable.

The value of this work will be considerably augmented by an arrangement which has been effected with the Bureau of Entomology whereby this Bureau establishes and maintains at the Sugar Experiment Station the laboratory for the investigation of insects injurious to sugar cane. These investigations are in charge of Mr. D. L. Van Dine, formerly of the Federal Experiment Station in Hawaii. Simultaneously with the study of the sugar yield and tonnage value of the varieties newly propagated by the Sugar Experiment Station, Mr. Van Dine proposes to study their insect-resisting properties so as to aid in the selection of those canes which may be fit to be disseminated throughout the State to be grown commercially.

A similar cooperation will probably be obtained from the Bureau of Plant Industry in the way of pathological investigations along the same line.

[Presented by Committee on Breeding Sugar Crops, Dec. 9, 1910.]

SINGLE-CHARACTER VS. TOUT-ENSEMBLE BREEDING IN GRAPES.

T. V. MUNSON, *Denison, Texas.*

INTRODUCTION.

In my work in breeding grapes and other fruits, the prime object was not to discover fundamental laws of inheritance *first* and then to practice those laws to get results, but, acting on the great universally accepted truth which is impressed upon us everywhere in organic nature—that each individual, each variety, each species, reproduces closely after its own kind, and yet is ever varying one way or another from the parent form—to proceed at once by selecting and combining parents embodying to the largest extent the characters desired, to attempt the production of offspring coming nearer to my ideals than either parent. As I proceeded, I kept close observation on results of uniting different mates with the mother, so that I soon found myself unconsciously searching for "laws" or methods of action under different circumstances. After all, that is all we mean by the term law in nature—*method of action under certain circumstances.* As the circumstances are infinitely variable so the "laws" are infinitely numerous, past fully finding out.

It would be just as reasonable to instruct a chess player to make every move according to laws of chess as for a breeder to require every new individual plant or animal to be bred according to the laws of heredity. The best move in a game of chess is the one that at that particular stage of the game goes farthest toward mating the opposing king and at the same time preventing the mating of the player's king. This, it is true, is in itself a "law"—a very vague and general law—that every chess player, good or poor, observes to his best ability, but that which makes him win most games is skill to penetrate more deeply into the possible combinations within the next few moves ahead, and to pick out that move each time most favorable to his side of the game. The skill is mostly the product of two chief factors—first and most important, natural acuteness in observation and thinking; second, much experience in the play. So it is with the breeder.

Breeding, like chess-playing, is an art. Yet there is a science of chess, and a science of breeding—classified facts with reference thereto—the knowledge of which greatly aids anyone who engages

in it to become expert. This science comes from those who have gone before. Hence each expert owes it to the race to give his accumulated clearly demonstrated facts in classified order. The study of these facts sharpens the wits and aids much in developing the expert. The best and the proper time to study them is when we are putting them into practice.

The science of breeding with all its complexities is new and only partially developed, and there yet remain to be worked out many more or less general truths and a vast multitude of details before any complete work can be compiled on breeding.

In breeding, only specialists can accomplish the greatest good. The universal breeder is even less likely to accomplish permanent beneficial results than is the "Jack of all trades" to make great success in business.

The following statements are based on the writer's experience in the breeding of grapes.

To get form, or size, or flavor; to get persistence to pedicel, non-cracking skin, even ripening, or certain season of ripening; to get resistance to parasitic enemies, especially fungus and bacterial parasites; to get drought resistance, heat resistance, cold resistance, or resistance to excessive wet; to get productiveness and long life; in fact to get any desirable character in the seedling, it was quickly seen that such character must be found in the parentage somewhere. This is simply the first universal law of inheritance in different applications, and can be practiced by any "lunkhead" if dealing with only *one* characteristic, but in general-character breeding, the keenest wit is required to get desirable results.

SINGLE-CHARACTER BREEDING.

If a person should seek only to produce grapes with the largest possible berries, he would neglect all other characters and choose at first such parents as Black Hamburg, Union Village, Eaton, Red Giant, etc., and cross any two of them. Then from this progeny he would select the two largest and cross again, and so continue. But the breed would soon be so weakened by in-and-in breeding that it would require "new blood" to revive it, so he would be compelled to start with four or eight parents, uniting into four pairs, and then uniting the largest product of any one pair with the largest of any other pair, and the largest product of the other two pairs united with

these, and then select seeds, and plant from the self-pollenized largest variety produced for several generations from this conglomerate parentage, until the vines would no longer endure in-and-in breeding without becoming too weak in vitality. Then the product would in all probability be valueless. So it would be had any other one character been used. Although in this kind of breeding only one character was kept in view, yet the final product is worthless in every character but size. Fortunately there are few who tend to single-character breeding, and those few should learn better ways.

GENERAL-CHARACTER BREEDING.

Every breeder worthy of the name seeks a product containing as many of the desirable points as possible. It is in attempting this that the real fine art of breeding begins. It requires the combining, certainly, of parents containing as many good and as few of the undesirable points as can possibly be found. This calls for wide and accurate knowledge, not only of existing varieties but also of all their characteristics and adaptabilities.

The breeder soon learns that some pairs selected, for some reason which he cannot perceive, are uncongenial, as is the case between human beings sometimes, so that no desirable progeny results, while other pairs are extra good breeders. No "law" can help him here. He has to learn by actual test. This is expensive, but it cannot be avoided.

It is quite probable that no two parents can be found to contain all the points sought. This requires the second, third, fourth, or later generations to be produced, and then only a very few of the plants of each generation approach the ideal. Bad qualities perhaps, at first concealed as "recessives" (according to the Mendelian writings), crop out and must be eliminated. So the successful breeder must not only be a careful selector but a rigid rejector, and a perpetual keen-eyed, quick-witted student.

I do not mean to say that the breeder of grapes need not know and observe the general laws of breeding already discovered; on the contrary he must observe these consciously or unconsciously to obtain success above the ordinary method of planting indiscriminately gathered seed. Happily the general laws are so few and simple that almost every person of fair observing powers and ordinary information understands them.

The great general laws may be stated thus: Like purebred parents produce like, with slight modifications produced by environments; unlike combined produce, in the first generation, all degrees of variation between the two parents; the progeny of the unlike combination, if self-pollinated, produce three classes of progeny—one-fourth like one parent, one-fourth like the other, and one-half variable between the two unlike parents of the first generation. This is known as the Mendelian Law of Heredity. In grape breeding, little is gained by combining like purebreds, but combinations of the best unlikes may be continued until a decidedly more desirable form than before existed for the purpose is secured.

It is the conceiving of ideal varieties for different seasons, climates, soils, and purposes, and the finding of those already in existence which come nearest to the ideal, and of these the ones most congenial in crossing and hybridizing and that go farthest in combination toward reaching the ideal, that makes a progressive and successful breeder. Such a breeder, taking up a single class of fruits such as grapes, if he seeks to cover all the seasons of ripening, all soils and climates capable of yielding profitable results, and all uses of the fruit, undertakes a lifetime service in experimentation which largely curtails his ability to make money.

Fortunately such work is fascinating, and, if good business methods are used in marketing the products originated, it should yield a comfortable living. Such a life yields one satisfaction that a life devoted to money getting generally lacks—the knowledge that it leaves a great beneficial legacy to coming generations.

The planters of vineyards, especially, reap profit from such work; the consumers are regaled with finer colors and richer flavors than could be enjoyed without the originator's varieties, and the breeders that follow are greatly aided by his recorded experience, if this has been duly classified and published, hence he should be paid good prices for the best products of his breeding.

As we cannot hope to excel the best examples in nature as regards ability to survive the destructive influences of climate, disease, etc., we take these best examples as a basis on which to ingraft, by crossing and hybridizing, the desirable individual characters of color, size, quality, etc., found in other individuals. But it is a general rule that the varieties of fine quality—especially the property of sweetness—are more affected by climatic extremes and more subject

to fungus and insect attacks than the hardy stock selected for resistance, and thus we find ourselves ingrafting weakness, reducing the hardiness of constitution, to gain quality. The usual result is a product reduced in quality from the high-quality parent and lower in hardiness than the extra hardy foundation. But we find that some of the hybrid individuals have retained much more hardiness than others, and some much better quality than others, and a very few possess largely both hardiness and improved quality. We seize these as the prizes vouchsafed us for our labor, and cross and recross these better combinations among themselves, and with still other fresh blood, until we have arrived at a greater perfection than is possessed by the varieties in general cultivation; when we can truly say the originator has a product worthy to be placed on the market. To ascertain adaptability to season, soil, and climate is as much the work of the prospective planter as of the originator; for, if the originator attempts to test in all regions before selling, it costs more than ever returns to him. Experiment station tests, under restrictions, should do this work; but experience proves this usually a losing game to the originator. Probably the best the originator can do is to give several years' test in different soils and situations, entirely subject to his control in propagation, before naming or introducing. Then he must charge what seems a high price per plant and advertise extensively to get a meager return for what has cost him years of most skillful work. It is in the first three or four years after introducing only that the originator derives mentionable returns. None of the bad products must be put on sale, or the reputation of the breeder suffers at once, and it is doubly difficult to regain what is lost.

The greater the number of desirable characters sought to be embodied in a variety (and a single individual is equivalent to a variety in fruits to be propagated by cuttings, budding, layering, or grafting), the longer and more difficult becomes the work. The process may be continued interminably with gradual improvement, as we are entitled to infer by comparing the poorest with the best in nature and art, and finding there is room to add to the best; and this encourages us to forever aspire with confidence to a still better future in special breeding.

SOME SPECIAL OBSERVATIONS.

Some breeders of grapes have assumed that it is a "law" that the female parent transmits vine characteristics, while the male transmits fruit characteristics, in the vines produced by crossing or hybridizing. This, I find, is not a law of reproduction among grapes. For example, in a lot of hand-made hybrids between Rommel as mother, having a peculiarly flavored white grape and distinct vine and foliage, and Brilliant as pollen parent, having a red grape of distinct flavor and a vine different from that of Rommel, the resulting hybrids all had vines very closely resembling Brilliant, while all had berries much resembling Rommel in flavor, and in color they were very nearly the same—all white. The size and shape of clusters, however, were in all like Brilliant. In hybrids of America (black) with Delaware (as male), the vine is an even combination of the two parents, but the berries and clusters are much more like Delaware, being translucent red. The flavor is a fair combination of those of both parents. Many other examples I could mention prove that there is no such law among grapes.

It seems in many cases there is no telling beforehand which characters in the parents will be dominant and which recessive or evenly blended in the progeny. In some combinations, all the characters of one parent are dominant and, of course, all others recessive. This is true of *Vitis rotundifolia* (as female) when united with varieties of true bunch grapes, the Rotundifolia characters being dominant. A similar result generally follows when a species of a very uniform fixed set of characters is united with a species that is quite variable, and I think may be set down as a law among grapes, and may be stated thus: *Species of grapes very uniform in character when hybridized with species of very variable character give progeny with the characteristics of the uniform species dominant.* This I have determined with several pairs of species to the second generation.

[Presented by Committee on Breeding Tree and Vine Fruits.]

DETAILS FOR A GAME BREEDERS' LAW.

DWIGHT W. HUNTINGTON, *New York, N. Y.*

It cannot be denied that a law permitting breeders to profitably increase our game should be enacted in every State. As I said last year, it seems idle to suggest to breeders that they should not be permitted to breed.

The resolution adopted by your Association has now been before the people for a year, and it was given a wide publicity by the *American Field,* the *Amateur Sportsman,* and other papers and magazines, yet so far as I am aware no one has openly said a single word in opposition to the resolution.

So far as I know all of our prominent naturalists are in favor of the protection and increase of North American game by breeders. A number of them have referred to this important matter in no uncertain terms. Dr. Hornaday has said: "The situation is absurd and therefore can not long endure." Dr. Merriam, chief of the Biological Survey, has written that he is strongly in favor of a regulated sale not only of deer but of game birds when properly identified. Dr. Shufeldt says: "I am thoroughly in sympathy with you in what you have to say and what many of your correspondents say on the question of game protection. There is such a thing as protecting birds off the face of the earth, and I stand distinctly opposed to much that pertains to such methods now in vogue."

So far as I am aware no sportsman of any prominence is opposed to the profitable increase of game by breeders. It is a self-evident proposition that the farmers, game dealers, and innkeepers, who will be benefited by a breeders' law, are in favor of it. Many of them have said that such a law would quickly increase the game.

Some of those who have been active in building up our restrictive system in the hope that it would increase the wild food birds, or at least save them from extermination, have made inquiries as to the form of a breeders' law which would enable breeders to sell their birds without endangering the rare and vanishing species which are supposed to be protected by the present game laws.

There are three well-known laws permitting the sale of game and game fish which may be taken as forms or precedents by those who may undertake to prepare a breeders' law for any State. (1) Colorado has had for several years a law permitting the sale of game

from preserves, and under this law the game birds are sold and served in the hotels. The State game commissioner has said the law should remain permanently. (2) Minnesota has a law permitting the sale of trout by breeders, and the executive agent of the board of fish and game commissioners informs me that this law is satisfactory and that it does not result in a loss of trout from the public waters. (3) Massachusetts has a new law permitting the sale of pheasants by breeders, and I know of no objection to this law save one which I have raised: its tendency must be to increase the foreign fowls instead of our own, which easily can be made abundant.

There are other similar laws, some relating to deer only. One law permitting the sale of birds by breeders in North Dakota has been recently enacted, but it has not been on the books long enough for us to know how it may affect the game which no one looks after properly.

My suggestions for the details of a breeders' law briefly are as follows:

Breeders should be defined so that those who own no interest in the game reared may, for the present at least, be prohibited from selling game. Permits or licenses should be issued to breeders upon the payment of a small sum, and the law might provide for the forfeiture of the license provided the person holding it ceased to be a breeder.

Provision should be made for licensing game dealers, and they should be required to give a bond to keep a game register wherein they should enter and list all game received and the names of the breeders sending it. Dealers might be required to file an affidavit at the end of the season stating that no game had been sold illegally. I have been informed that in England, where game is sold during a good part of the year, the reputable dealers are opposed to the few who are suspected of violating the laws, and willingly aid in their apprehension.

It should be far easier for game officers to watch a regulated industry than it is to oversee such sales of game as are now permitted—game birds coming from points distant 25 miles from New York, for example.

One thing we should always bear in mind—the laws should aid the vigilant and not the sleeping. Those who are willing to properly protect and increase our splendid grouse, quail, and wild fowl should be encouraged. Nothing can be accomplished without the expenditure of money, and no one can be expected to invest in an enterprise which

is practically prohibited by law. If any loss should occur by reason of the proposed change in the game laws it must fall on those who do nothing, and it will be more than offset by the game reared by breeders.

Under the present game laws we have State game departments which represent only a small part of the people—a part of the sportsmen, but not all of these by any means. Necessarily these departments are hostile to the farmers, the game dealers, the innkeepers, and all of the people who would be benefited by cheap game. The State game departments under a breeders' law will represent all classes of people, as any governmental department should.

The effect of the resolution which the American Breeders Association passed last year has been good. The proposed breeders' law has been much discussed by sportsmen, and as I have observed there is none who is openly opposed to the common-sense idea that the breeders of game should be permitted and encouraged to rear game birds for the market. Ruffed grouse today are worth $20 a pair for propagation, and there is a demand for a large number of them. I know a man who successfully reared these birds last season in a wild state on a small country place quite near New York. On the same ground he reared mallards and several species of quail and some Hungarian partridges. Since most of the birds were nesting wild they procured a good part of their food from the few acres of field and scrub oak. The cost of rearing these valuable birds under such conditions should be less than the cost of rearing poultry. No one is permitted to fire a gun on the place. Why should the owner of these birds be prohibited from selling some of them for propagation or as food? Mr. Evans, who has prepared a paper to be read before your Association, informed me (a few days ago when he wa sin New York) that he had about a hundred cock pheasants left over last season; since most purchasers bought more hens than cocks. Why should he be prevented from selling these extra birds as food?

In order that something may be done toward securing a breeders' law which will be satisfactory to all classes, I would suggest that you appoint a special committee to consider the form of such a law and to recommend its enactment by the various State legislatures, provided the members of the committee agree upon the form of law which will benefit all classes. I would advise that you appoint a committee of nine, to be made up as follows: Two farmers; two sportsmen; two game dealers (one to be a dealer in live game); two hotel

keepers, and one prominent naturalist. I would suggest that at least one of the first named be the president or other prominent officer of a grange; that one of the sportsmen, at least, be a prominent member of a State game protective association, and one be appointed from those who favor a breeders' law; that one of the innkeepers be the president of a State hotel men's association; and that Dr. Hornaday, Dr. Merriam, Mr. Brewster or some other naturalist be appointed to advise the committee about the natural history facts which should be considered.

I believe a law can be drawn which will prove satisfactory to all of these classes and which will be beneficial to the people who wish to see cheap game in the markets. I am sure that a law which is satisfactory to all classes will remain permanent and that it will be in pleasing contrast to the ever-changing and ridiculous game laws which are annually placed on the books and which consume from one-tenth to about one-third of the time of the legislative assemblies.

THE BREEDING OF GRAIN SORGHUMS.

CARLETON R. BALL, *Washington, D. C.*

STATUS OF THE SPECIES.

Present View.—It is now generally acknowledged that all the numerous cultivated varieties of sorghum belong to a single subspecies, *sativus* Hackel. It is further held that they have been derived in the lapse of centuries from somewhat parallel variations in the spontaneous subspecies, *halepensis* (L.) Hackel, represented in this country by the well-known Johnson grass of the South. These two subspecies together comprise the species *Andropogon sorghum*. This opinion forms, as it were, the apex of a nomenclatorial pyramid of widely differing views.

Progressive Development of this Idea.—About a century and a half has elapsed since the adoption of the binomial system of botanical nomenclature. In that period four distinct conceptions of the botanical status of the numerous wild and cultivated forms of sorghum have been held. These four ideas were developed in somewhat definite succession, though their periods of dominance overlapped. In them sorghum forms have been regarded as: (a) Distinct botanical species;

(b) subspecies and varieties of two distinct species, one the wild *A. halepensis,* the other the cultivated *A. sorghum;* (c) subspecies and varieties of a single species, including both *A. halepensis* and *A. sorghum;* and (d) agricultural varieties of a single botanic species.

The wild subspecies is found abundantly in all tropical and subtropical parts of the Old World. Its varieties are numerous, and their main lines of variation are parallel with those represented in the major groups of cultivated forms. This is especially noticeable in comparing the forms assumed by the wild and the cultivated plants in Africa and to a lesser extent in India also. It is thought to indicate the origin of different cultivated groups from somewhat parallel variations in the wild subspecies. It is also evidence of an independent origin of cultivated sorghums in the two continents.

PHYSIOLOGICAL FACTS TO BE NOTED.

Cross Fertilization.—All sorghums are adapted to open or wind pollination, and most of them are probably equally adapted to self fertilization. Just to what extent cross fertilization takes place under normal field conditions it is, of course, impossible to say. However, in the case of adjacent rows of different varieties flowering on approximately the same dates, as high as 50 per cent of the seed produced by the leeward row has been found to be cross-fertilized. It is probable that in a fairly uniform field of any given variety a similar percentage of natural crossing takes place. Many writers have stated that such cross pollination occurs also at very long distances, but this seems to be less conclusively proved. Probably a distance from 8 to 10 rods to leeward is the maximum at which appreciable hybridization occurs. In the Plains region, where sorghums are largely grown and where constant diurnal southerly winds are the rule, the greatest proportion of cross fertilization is experienced. The injury from this source would doubtless be still greater than it is but for the fact that most of the pollen is shed during the early morning hours, when the winds are usually of lower velocity than during the day.

Extreme Variability.—The range of variation in different groups and varieties—seen particularly in the size of the vegetative parts, in the coloring of the glumes and seed coats, and in the size and shape of the grain—is fully as great as and probably greater than in the case of any other cereal group. This variation is doubtless due to the ease and frequency of cross fertilization, as well as to the great antiquity

of cultivated sorghums, dating, as they certainly do, from the most remote historic times.

Vegetative Vigor.—As we have seen, sorghums are of tropical origin, and, like many annual tropical grasses, they have a natural tendency toward great vegetative vigor. This is shown, first, by the great size which many of them are known to attain in their native homes; second, by the extreme vigor of growth shown by nearly all forms when first introduced into the United States, even in semiarid regions; and, third, by the enormous size always developed by some of the resulting forms in cases of cross pollination, even though both parents be of small stature.

Susceptibility to Improvement.—As a corollary to the preceding observations stands the great susceptibility of these crops to selective improvement. That this has always been true may be inferred from the wide range of uses to which we find the sorghums adapted in their native lands and among more or less primitive peoples. Four entirely distinct products are commonly secured from specialized groups of sorghums, viz., grain, forage, saccharine juice, and brush. In the forage groups the plants are variously used for pasture, soiling, silage, fodder, or hay. In certain countries the culms and leaves are used for thatches, fences, baskets, etc., while both stems and roots serve as fuel. It must be remembered that in Africa, India, and China practically all varieties are grown for human food.

STRONG ECONOMIC FACTORS.

Drought Resistance.—To this factor more than to any other the sorghums owe their widespread cultivation in the United States, especially in the western portions, and in similar regions of other lands. In just what this drought resistance consists is not surely known, but there can be no doubt of its existence. It is probably due to a combination of at least three causes and perhaps more.

First of all stand its adaptations for reducing transpiration. These are the close involution of the leaves under conditions of extreme drought, and probably, also, the waxy, powder-like secretion found on the stems and sheaths where no involution of epidermal surfaces is possible. These adaptations enable sorghum crops to remain dormant during comparatively long periods of drought and to resume to a greater or less degree their normal growth when the unfavorable conditions have been removed.

The second cause is the lower water requirements of the crop in comparison with other crops having a similar habit of growth, such, for instance, as corn. By this is meant the ability to produce a maximum weight of grain upon a minimum weight of plant. Whether there is present also the ability to produce a ton of dry matter with an actually smaller tonnage of water than other crops require is another question and one not yet answerable. Of the first fact, however, there seems little doubt.

In the third place, there is a possibility that sorghums possess superior drought resistance by reason of superior ability in the mechanical extraction of capillary moisture from the soil particles. There are, however, no proven facts to substantiate this theory.

Disease Resistance.—There are two great groups of fungi which are the especial scourge of cereal crops, viz., rusts and smuts. The grain sorghums apparently possess a high degree of immunity to injury by rusts. Only one species of rust, *Puccinia sorghi* Schw., is known to occur on sorghums in this country, and the injury it inflicts is so slight as to be entirely negligible from the economic standpoint. Two species of smuts, the kernel smut *(Sphacelotheca sorghi* (Link) Clinton), and the head smut *(Sphacelotheca reiliana* (Kuhn) Clinton), are prevalent throughout the sorghum-growing regions of the whole earth. In this country a very large amount of damage is done by the first species, which, fortunately, is easily controlled by the hot-water treatment.[a] It is known to affect all the groups of domestic sorghums except milo. The resulting loss in the seed crop sometimes runs as high as 50 per cent, while a loss of 10 per cent is oftentimes quite general throughout a community. The head smut also affects all crops except milo. It is not yet of widespread occurrence in the sorghum region, which is the more fortunate in view of the fact that no successful treatment for it is known.

The cause for the peculiar immunity of milo, dwarf milo, etc., to both species of smuts is wholly unexplained. That they are immune, however, is a well-known fact and an important one also, because of their high value as grain-producing varieties, and because of the hope which it gives that smut resistance may be developed in other groups than milo.

[a] Freeman and Umberger, The Smuts of Sorghum. U. S. D. A., Bu. Pl. Ind., Circ. 8, 1908.

Adaptability.—Grain sorghums possess qualities which adapt them to use in a variety of ways and under widely differing conditions of soil and climate. Their extreme range of variability in stature and in time of maturing, the causes for which have been previously mentioned, are of the greatest value and promise to the breeder. Early strains have been produced for use in high altitudes and latitudes with a consequent short growing season, or for the farmer who would follow them with fall-sown crops. Dwarf varieties are now in hand for the wheat raisers who would harvest them with the grain header. Heavier and later varieties exist for the man who has a long season and the need for a combined grain and forage crop. They are adapted to growing in windy regions without loss by lodging. They are cultivated crops for use in rotations where clean tillage is desired. This especially adapts them for use in semiarid regions where methods of moisture conservation are the chief care of the farmer.

Productiveness.—One of the strong points in favor of grain sorghums is their comparative productiveness in the regions in which they are so largely grown. Their grain-yielding ability is indeed remarkable in view of the short time since their introduction and the low yielding power of many of them in their native homes. It is only about thirty-five years since the first grain-producing varieties reached the United States. Two durras were imported in 1874, two kafirs in 1876, and milo about 1885, less than a quarter century ago. The kafirs, however, did not come into general cultivation until a little more than twenty years ago, and milo at even a later date. The kowliangs are of very recent introduction. It is thus seen that these grain sorghum groups have been under scientific selection and improvement for periods of from three to no more than thirty years, and yet in that time they have been redeemed from some of their most glaring faults and made capable of average yields varying from 25 to 50 bushels of grain per acre.

CHARACTERS NEEDING IMPROVEMENT.

Pendent Heads.—The pendent or goosenecked heads, common in the durra and milo groups, are an especial nuisance. They not only prevent the satisfactory use of any type of header in harvesting the grain, but they are in an awkward and dangerous position to cut by hand. It is a common sight in the milo belt to see men at work with one or more bandages covering wounds on the left hand, made by the

knife while cutting heads from recurved peduncles. This recurved stem is also an objection where the whole stalk is cut with the corn binder or grain binder. It prevents the stalks from lying parallel when cut. It frequently interlocks with adjacent stems so that they can scarcely be separated in field or shock. It also makes the tops of the bundles wider than the bottoms, thus forming shocks that will neither withstand wind nor turn water. The heads are normally erect in all kafirs, kowliangs and shallu, as well as in some durras.

Shattering of the Seed.—This fault was so characteristic of the two durras first introduced as to practically drive them from cultivation in spite of their splendid drought resistance and extreme earliness, both most valuable qualities. The shattering habit does not yield readily to selection. Fortunately it is not present in milos, kafirs, or kowliangs.

Incomplete Exsertion of the Heads.—Serious loss is occasioned by the failure of the head to become completely exserted from the upper sheath. The included base usually becomes infested with plant lice, corn worms or false army worms, and finally becomes moldy and rotten. A twofold damage results, first, the loss of the seed on the basal portion of the head, and, second, the loss of often larger quantities of seed through contact in shock or bin with this decayed matter. In none of the grain-producing groups is the head normally exserted more than two or three inches on the average. The kowliangs have the greatest average exsertion, the kafirs the next greatest, and the durras and milo the least. White kafir, the variety earliest grown in this country, has been entirely discarded because it ordinarily failed of complete exsertion. In the milos and many of the durras exsertion is accomplished, not by actual projection of the head above the apex of the sheath, but by a lateral bending or inclination of the peduncle which forces the head out of the open side of the sheath. In this case the strongly inrolling margins of the firm sheath often retain a hold on the side of the panicle, with the same results already noted in normal inclusion of the head.

Production of Suckers and Branches.—There is in all sorghums an inherent tendency to stool or throw out suckers from the base of the stem. In cereal crops this is usually considered a desirable character because it enables the grower to secure the maximum number of stalks from a minimum quantity of seed. It also enables nature to compensate in some measure for a poor stand. The same effects are

secured in the case of sorghums. The question is, then, whether or not these effects are desirable. In the judgment of the writer they are not, for several reasons. First, the quantity of grain-sorghum seed required to sow an acre is so small that there is little need to economize in its use. Second, however it may be regarded in small grains, the later ripening of the heads on sucker-stalks can be considered only as a distinct disadvantage in grain sorghums. Early and uniform ripening is very desirable in these late-sown spring crops in order to insure escape from frost, as also for other reasons. Third, suckers do not usually grow as tall as the main stalks, which is a serious matter in tall crops designed to be harvested with any type of header.

Branching from the upper nodes is quite unknown in small grains and quite rare in corn, but fairly normal for sorghums, at least under certain conditions. It is most pronounced in humid climates or in humid seasons in dry climates. It commences at the time when the main head is nearly but not quite mature, and is a very objectionable habit. The first branch appears at the first node below the one bearing the main peduncle, the second branch a little later from the next lower node, and so on in regular sequence. This production of branches retards the ripening of the main crop of heads, makes the plant top-heavy and liable to lodging, causes difficulty in harvesting by any method, and endangers the keeping quality of heads or seed in bulk, through the introduction of unripe material.

Tannin Content of the Seed Coats.—Small quantities of tannin are normally present in the seed coats of all brown or red seeds. The quantity varies with the stage of maturity and with the variety. Immature seeds contain more than ripe seeds. The seeds of the sorgos or saccharine group and of brown durra contain the largest quantities, the brown kowliangs the next largest, and red kafir and the milos the least. White seeds contain practically none at all. It is probable that its presence causes damage through rendering the seed less palatable rather than through any ill effect produced by the astringency.

Irritating Hairs.—The glumes of many varieties are more or less densely clothed with short hairs which are exceedingly irritating to the skin, especially when it is wet with prespiration. The kafirs and kowliangs have small glumes only thinly hairy and cause little trouble. The milos have longer glumes but these are only thinly clad. The durras, on the other hand, have large glumes and a dense pubescence

which makes their threshing an exceedingly uncomfortable task. This objection is perhaps only a minor one, but seems worthy of attention by breeders. All the kowliangs and milos, as most of the durras, have small, bent, and twisted awns attached to the lemmas (flowering glumes). None of the kafirs is thus provided. These awns also add to the mechanical irritation suffered by workmen at threshing time and seem to serve no useful purpose.

SECURING FOUNDATION STOCKS.

Importation of New Forms.—As already indicated, sorghums are extensively cultivated by native peoples throughout Africa and in considerable parts of India and China. Our few domestic varieties have all come from those sources within the last 35 years. Importations within the last 10 years have numbered more than 600 separate lots of seed, consisting almost wholly of forms used for grain production by the native growers. Many of these importations seem to be wholly unsuited to use for any purpose, under our climatic conditions and methods of farming. Many of the remainder show little indication of value as grain producers. However, a small number of promising new varieties are now being developed from them. Among these are several kowliangs from Manchuria and North China, one or two new kafirs from southeast Africa, one or two durras from India, and at least one durra from the Sudan. It is quite probable that in this and other little-known parts of Africa there exist varieties awaiting our discovery which will prove even more valuable than any we now possess.

Selections from Domestic Fields.—Here is the most likely source of material for the breeder. These crops are such recent additions to American agriculture and so little known to the body of plant improvers that some of their most valuable characters or tendencies may easily have been overlooked. They are naturally so variable that a field presents numerous opportunities of founding new strains by selection from its component forms. In this way the writer has founded his dwarf or "baby" strains of milo and blackhull kafir, and is now fixing similar forms in other varieties. So, too, have been produced the varieties of durra and milo with erect heads.

Hybridization.—As we have seen, sorghums cross naturally with the greatest readiness and have doubtless been originated in their present forms largely through this agency. Crossing to obtain certain

desirable combinations of characters will probably prove one of the most fruitful fields of endeavor in the line of sorghum breeding, although a period of several years is likely to be required for fixing hybrids in forms suitable for profitable use. The writer has a number of third and fourth-generation hybrids between members of two different groups which are producing fairly uniform plats of desirable character.

PLANS FOR BREEDING.

The widespread need and demand for varieties of immediate value on the farm is so insistent as to leave little time for any survey of the broader scientific aspects of grain-sorghum breeding. The work has therefore been almost wholly confined to the strengthening of desirable qualities and the elimination of undesirable ones. Along these lines the work will need to proceed for many years to come.

The essentials of such breeding are to determine the lines of improvement needed; to recognize lines of variation in the plant which parallel this need; and to fix these variations in the improved crop. The chief desirable qualities or characters to be secured in grain sorghums are productiveness, earliness, dwarf stature, erect peduncles, exserted heads, seed-holding power, drought resistance, disease resistance, freedom from suckers and branches, absence of hairs and awns on the glumes, and absence of tannin in the seed coats.

In these breeding experiments the head is commonly regarded as the unit, although, of course, this is not true unless cross pollination from adjacent stalks of the same variety has been prevented by artificial means. As many seeds from the selected unit-head as may be desired are used for planting the breeding plat, which may be any desirable or convenient unit of area. From this plat are selected the heads from plants most closely complying with the requirements of the purpose for which selections are being made. Each head so selected is made the basis of a new breeding plat in the succeeding season. If strict inbreeding is to be practiced, the heads to be used must be bagged as they begin to emerge from the sheath, in order to prevent cross pollination. If cross pollination within the limits of the breeding plat is desired, it is necessary only to insure that pollination from adjacent plats does not occur. Selections for earliness should be made at the time of heading and verified at the time of ripening. Other selections are made principally at the time of maturity.

TESTING PROGENY.

The method of measuring breeding results must vary, of course, with the purpose for which the plant is bred. Other things being equal, determining the results of selections for earliness is a matter of dates of planting and ripening. Improvement in productiveness is shown by yields and in dwarf stature by inches of height. The test of elimination of branches, suckers, recurved peduncles, and included heads is a mere matter of counting totals on units of area. Always, however, this depends on "other things being equal." But other things never are equal in experimental work. Seasonal variations and soil variations together utterly prevent such a happy result, by their influence both on the stand and on the growing crop. Obviously, the rate of annual improvement cannot be measured except by taking the average of results secured in a series of years. Properly, a portion of the selections made in all previous years should be grown adjacent to the selections of any given year. In this way a series of plants of different degrees of improvement would be growing side by side each year, subject to approximately the same conditions of environment and affording a fair indication of the annual progress being made. However, when a large series of breeding experiments is under way and is being continued through a number of years, it is manifestly impossible to duplicate them in this manner each season, even on a very small scale. Considerations of time, money, and available land ordinarily prevent.

SOME PROBLEMS TO BE SOLVED.

In conclusion, I submit a few questions for the consideration of investigators and plant breeders.

1. At what distances does cross pollination take place under different conditions, in different sections of the sorghum belt?

2. In what does drought resistance consist?

3. How may inherent drought resistance be determined and increased where no strongly resistant sports are found?

4. Are sorghums able to produce a ton of dry matter with the use of fewer tons of water than other grain crops?

5. In what does disease resistance reside, and how is complete smut resistance of milo to be explained?

6. Is the production of suckers a desirable or an undesirable character in grain sorghums?

7. What causes the recurving of the peduncle in some varieties?

8. Is there reasonable hope of successfully growing grain sorghums drilled like small grains or millets, and harvested in the same manner?

9. Do awns and glumal hairs serve any useful purpose which will be defeated by their elimination?

10. Should selections for earliness be made at the time of heading or at the time of ripening, or both?

[Presented by Committee on Breeding Cereal Crops.]

REPORT OF COMMITTEE ON BREEDING COTTON.

D. N. SHOEMAKER, *Chairman, Washington, D. C.*

The most disturbing factor in the whole cotton-growing industry continues to be the steady advance of the Mexican boll weevil. The necessity for breeding of earlier types of long-staple upland cottons has reached an acute stage, because the region where most of this cotton is grown has been invaded, and is now infested sufficiently to make a scarcity of this type of cotton. So far the damage resulting from the weevil has been greater in this humid region than in the drier parts of Texas.

This crisis is being met in two ways: First, by the use of Columbia cotton, a variety originated by Dr. H. J. Webber, by selection from Russell's Big Boll. Columbia has attained great prominence in the long-staple region in Mississippi, since it is earlier than the varieties now grown. Second, by the introduction of a variety with long-staple which is still earlier. This variety, which has been named the Foster cotton, is yet in its infancy but it is in great demand. It is a cross between Sunflower cotton, an old-time long-staple variety, and Triumph, an early big-bolled, short-staple variety.

The Department of Agriculture is this year making a distribution of a new variety of cotton for Texas conditions, which has been called Trook. It is early, large-bolled, very productive, and with a very high percentage of lint. It is a cross of Triumph on Cook's Improved, the later variety being an eastern big-boll cotton with a high lint percentage.

Mr. O. F. Cook has a strain of Mexican cotton from the state of Durango which showed very favorable results in a number of plantings in South Texas in 1909. This cotton has lint about 1¼ inches long, and is early and productive.

The wilt-resistant varieties distributed by Mr. W. A. Orton for the eastern cotton region are giving excellent satisfaction to those regions where this disease is a serious factor in cotton production.

Since cotton is an open-fertilized plant the question of the amount of crossing becomes very important for the breeder. It is a subject which has been too much neglected in the past. The amount probably varies with localities, and with seasons, and may be different with different months of the same year, depending on the variations in the insect fauna. For this reason experiments should be planned in many places, and for more than one year.

Two papers are presented this year bearing on this subject, one on conditions in northern Georgia in 1908, and one for central Texas of the same year.

These results are not entirely comparable, but both indicate a considerable amount of crossing. It is planned to have other experiments ready for report at our next meeting.

EDITORIALS

Study of Eugenics New.

When in 1906 the American Breeders Association created its Committee on Eugenics the orderly study of eugenics was comparatively new, so that no clearly defined plans existed for studying it on a comprehensive scale. That committee has gradually developed plans and enlisted efficient workers to fix in the public mind the fact that this is both a proper and profitable line of inquiry. To this end attention has been directed to those larger phases of the subject which are wholesome and normal, and the efforts of those interested in eugenics will be to guide the discussion along the wholesome lines of thought in relation to the questions of heredity in the family.

Conservative Workers.

The men who have become leaders in this movement within the Association are an earnest of the conservatism and care with which this matter will be treated. Those persons who are constantly coming forward with new theories regarding such mooted questions as the control of sex will find opportunity to present any facts they may have to those officers and committeemen who are from time to time in charge of the Association's activities in relation to eugenics. But that which the Association will choose to make public along this line will be considered with the greatest care. Many of the papers with more definitely presented relations will be published only in the Annual Report. The *Magazine* will deal with the more general and popular phases of the subject. The leaders of this movement request a period of investigation and that the period of teaching may not be begun too soon. Those persons who are interested and are willing to wait for substantial results will be happy in their association with the scientists who under the auspices of the Association courageously enter upon a broad study of heredity for betterment in man.

BREEDING, RESEARCH, AND EDUCATION.

The improvement of economic plants and animals by breeding is most closely associated with our institutions of research and education.

Public Aid to Breeding.

Not only is much of the science of heredity and breeding wrought out by those institutions, and not only are the men who do the work of creative breeding trained in our educational institutions, but our departments of agriculture and agricultural experiment stations foster and direct much of the actual work of creating new varieties and breeds.

The United States Department of Agriculture is especially active and helpful in introducing from other countries, and from one State to another, species, varieties, and breeds which may prove useful in new locations. Both the United States Department and State experiment stations are developing men trained in the science and experienced in the art of selective breeding and of making hybrid varieties and breeds. And these workers are gradually assembling and testing the varieties and breeds which have the most valuable characters needed to be recombined in varieties and breeds designed best to serve the needs of each local condition. Our public research and educational institutions have assumed the responsibility, (1) of developing a science of breeding, (2) of cooperating with private individuals and institutions in assembling the best obtainable species and varieties needed for creative breeding, (3) of assisting in the actual work of creative breeding, (4) of aiding in testing and distributing valuable new breeds, and (5) in educating men for public and private efforts in creating improved plants and animals.

Private Breeders.

The vast bulk of the actual work of variety and breed improvement, whether by simple and expeditious methods of selection, or by complicated hybridization followed by long-continued selection, must be done by private enterprise. While the public work should and will be rapidly increased it will be somewhat closely confined to research and education, and to cooperating with private breeders and with semipublic cooperative breeding enterprises. There will be a very strong temptation to nations, States, and institutions to assume the more commercial parts of this work. But, as in case of railway government, where the tendency is for public supervision of privately owned railways, so the general trend of thought in America is for private parties to own the plants and the

animals; the public to provide only supervisory and cooperative help. This plan can not be adhered to rigidly; for to do so would often place restrictions and limitations which would retard progress. On the other hand, vocational education promises to prepare farmers to cooperate much more effectively than now. With the rise of successful cooperation, farmers are more than ever ready to insist on individualism in the ownership of the family farm, and they would be loath to turn over to public management and competition such a branch of farm business as the remunerative and enjoyable business of breeding and growing pure-bred animals, seeds, and plants.

Extensive Research and Teaching.

The estimate stands unchallenged that by breeding the plant and animal products of the United States can be increased $500,000,000 annually, and the farm products of the world several billions. This would warrant that our research and educational institutions devote much effort to develop the science of heredity and to devise improved plans of breeding, and to train a large class of men to work under public auspices and privately as breeders of plants and animals. The research work in the United States Department of Agriculture, in State experiment stations, and in such institutions as the Carnegie Institute for Research could appropriately be multipled several fold.

This is also a most fascinating field of research for men with an income who wish to do a vital service as amateur researchers and breeders. In many cases these amateur investigators associate themselves with some department of agriculture or experiment station, or with the research laboratory of a university, with mutual advantage. The association of this practical and fascinating work with the university or agricultural college is of vast benefit as a source of information, inspiration, and help to students who are ready to choose a vocation, in self directing their life work. It is not likely that the demand for men trained in research in heredity or in the work of creative breeding, or in practical breed, seed or plant production will soon be overdone. There is room and remuneration for trained men, as well as ample room for men who are able and prefer to establish a private business, or to do research work at their own expense.

Cooperative Breeding.

It would seem that the Federal and State governments are doing well in carefully building up plans for the employment of limited sums of public money to develop cooperations—not corporations—for the general and creative breeding both of plants and animals. The cow-testing associations, the community ownership of breeding males, circuit associations to develop centers of the most efficient blood of certain breeds and to create therefrom more valuable new strains, are all forms of this general movement. Wide-open opportunities for increasing the values of our products by all these means are known to exist on every hand. And the need of public officers charged with the administration of public funds to build up the science of heredity, to devise improved methods of breeding, to assemble needed foundation stocks of plants or animals, to do selective breeding, or to make hybrids and to select from them, to assume the leadership in large enterprises which several years ago seemed over-ambitious, and also to multiply and distribute any resulting improved varieties and breeds, is becoming more imperative year by year. And men of genius and of organizing ability are learning that there are large and enticing fields of endeavor in the science and practice of breeding plants and animals, beyond the dreams of a decade ago.

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Creation of Varieties and Breeds.

The work of creating improved varieties or breeds is annually being made plainer and easier. On the other hand, plant and animal introduction has become a most fruitful branch of plant and animal improvement. The introduction into each region of all forms likely there to be of especial value, and placing them in such rigorous long-time tests that their true economic place may be determined, is becoming a large project. Whenever for this purpose public funds are intelligently used in cooperation with private growers a great service is rendered.

The farmer of each region should know which varieties of plants will yield the most per acre on each kind of soil, under each successful cropping and fertilizer scheme; and which breed of live stock will help the crops add the largest profit per acre; and he should also know which scheme of cropping, and which plans of uniting crops and live stock in systems of farm management, will give the largest net returns per acre and per worker. And an abundance of products is necessary,

not only to make profits for the farmers, but also to supply cheap raw products for the food and clothing of non-farmers.

When each region has secured many of the plant varieties and animal breeds for production in that region, highly trained and skilled men should be privately and publicly employed in creating from them new varieties and breeds of still higher power to aid in producing large net values per acre and per farm worker. These men will need not only the best and most practical standard varieties and breeds as bases for their work, but they need also any others which may have useful unit characters, which may be recombined by hybridizing with the best qualities of the standard varieties and breeds. Thus standard varieties which may lack in some essential point by hybrid or cross breeding, followed by most rigorous selection, may be made into still better kinds of plants or animals.

Creative breeders should have the organized, cooperative assistance of growers of pedigreed plants and animals. Plans are needed for wide cooperation between the Nation, States, associations, cooperative breeding organizations, firms, and private individuals. In no other field of agricultural expenditure will a dollar make so much profit as in general cooperation in scientific breeding, to create new varieties and breeds. Once a new value is created by breeding, further expenditure is avoided; while in the case of fertilizers, deeper plowing, more frequent cultivation, though these are profitable, the expense recurs annually.

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Clonal Varieties.

Clonal varieties of species of plants are propagated vegetatively. The new variety is based on a single seed producing a single plant—as the apple, by grafts and buds; the potato, by tubers; and the strawberry, by runners. The variety is, so far as heredity is concerned, made up of vegetative parts of the one clonal parent plant. The variety is the asexual progeny of a single seedling plant. "Clonal" breeding is therefore simply the search for the remarkable seedling mother plant, not remarkable for her power to project efficiency through sexual breeding, but of remarkable varietal value when cut up into many plants, valuable for her asexual progeny. Public breeding stations, nursery firms, seed firms, and private individuals, working separately or collectively, are thus creating many varieties. More public funds with which to bring about better organization of

cooperation would enable the public to induce more private efforts. Two controlling factors are the employment of immense numbers, and intelligent tests to assure finding the one desired mutation in many plants, often in many thousands of plants. And since the new variety very soon becomes public property, the use of public money is more than justified in choosing the necessary tens and hundreds of thousands of seeds; in growing a plant from each seed; in choosing the most promising plants; in growing and testing a clonal centgener plot of the progeny of each of these best individuals, thus to determine which produces the best variety; and, finally, in disseminating those very few clonal stocks which represent the largest varietal values.

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Procedure with Self and Open-Pollinated Varieties.

In creating *self-pollinated varieties* the new variety is based on a single seed, in this case producing a single many-seeded mother plant, each seed the result of pollination by the same floret. There is nearly as little breaking up from seminal variation as in clonal varieties; there is no adulteration by the admixture of pollen from other plants; and therefore the progeny of the one mother plant are all very much alike. Here again the work consists in finding the remarkable mother. But in this case the value must be transmitted through its seeds. The mother plant must possess the power of projecting high yields and values per acre through the generations of her progeny. She does not need to be prepotent, because no new blood is introduced. And the experience of many breeders has proven that only one of these highly efficient self-pollinated mothers is found in thousands or tens of thousands of plants.

The breeder of wheat, for example, passes through the field of wheat, and by picking one choice head out of a thousand he makes his first selection. These are weighed and the 10 per cent of the lot which have seeds of good quality and weigh heaviest are retained. These choicest heads are so planted that a short drill or hill row is grown from each head. When the crop is ripe the breeder throws out half or more of the rows, retaining only those which appear to be heavy yielders. Seed is separately saved from each stock, that the blood of each mother may be separately tested. The third year a longer drill row, a hill row, or a hill plat of a specific size is grown of the grandchildren of each mother plant, and the quantity and quality of

each of these newly born varieties is determined. Some which are poor in yield or quality are discarded. Chemical and flour-making tests are also made. In the fourth year the great grandchildren are grown in similar plats, and in the fifth year great-great grandchildren are grown in plats. Any varieties which come through all these tests with a high score are taken the sixth, seventh, and eighth years into field-test plats. The one or more very best varieties are now subjected to more rigorous tests in the mill and are subjected to field trials on experiment grounds in many sections of the country. In outcome the first trial of this kind was significant. The expenditure of $10,000 resulted in a new variety which has already covered 5 million acres of wheat land with a crop of 2 bushels per acre larger than the mother variety which it is displacing, and is extending to other areas and other countries.

If the expenditure had been $100,000 the result might have been a variety which would add 5 bushels per acre to our ridiculously low wheat yields. Expenditures which, as straight business propositions, return more than a million for a thousand can not be urged too enthusiastically. It costs relatively little to discover and conserve billions of dollars worth of heredity in our plant and animal forces.

In creating new varieties of open-pollinated plants we have yet another condition. Here the new variety can not be made from a single mother plant. The mutating plant can not simply project its efficiency in yield, quality, hardiness, etc., without interference. The pollen of another plant must be used in those plants which are accustomed to open pollination, and the mutating mother plant must project her unusual qualities forward through the progeny in spite of the other blood. She must be dominant in the vital characters, and the breeder must select the individual progeny in which desired dominants exist. Individually the word prepotency expresses the idea. But collectively we can not express the matter so simply. There must be dominance and the dominants must be segregated by selection, thus to secure as nearly as may be the recombination of peculiar and mutating values from the one or more remarkable mother plants in which arose the newly created values.

In the classic statement made to the American Breeders Association in 1907 by Prof. C. L. Williams, of Ohio, on breeding corn, methods are clearly portrayed for discovering what are and what are not mutating mother plants, and for discarding the blood of all mother

plants except that which makes good in the cross-pollinating network of descent which we call the new variety. These statements are not exactly easy reading, but once understood are as clear as mathematical processes, and they are eminently practical. And that Professor Williams and his associates are working out the faith that is in them is shown by the fact that they have organized a corn breeders' association in nearly every county of Ohio, with thousands of breeders producing pedigreed corn according to the Williams plan. They are striving to add 10 bushels of corn to the yield per acre in the State. That additional yield on Ohio's 4,000,000 acres would be worth $20,000,000 annually. No matter if it is difficult, and not a simple one-man matter, as in the breeding of the clonal varieties of apples, or in breeding self-pollinated varieties of wheat. As a matter of fact, the bond of union among several thousand corn breeders, the general experience and pleasure these men get out of the work, and the training in doing something well are worth the cost. Practically speaking, the $20,000,000 of added annual value of corn crop when it comes will be all real gain. The day has passed when plant breeders were scoffed at for assuming to talk in big figures when recounting the achievements and possibilities of this most creative of all work. Scientific breeding is a rapidly growing force in the production of food and clothing.

¶ ¶ ¶

Creating and Improving Breeds of Animals.

Comprehensive and effective creative work in animal breeding can not be done very rapidly nor with small expenditure. Here, as in corn and other open-pollinated plants, the blood of the mutating animal can successfully be used as the basis of a new breed only by a more or less complex route. Often inbreeding is resorted to with advantage, greatly lessening the amount of selection necessary to get the desired dominant characters segregated out into a network of descent which will project forward the desired result. Williams's corn breeding formulary contains basic philosophy which is applicable to creating new breeds and strains in live stock as well as in open-pollinated plants. And this is the very philosophy followed by such men as Cruikshank in creating Cruikshank Shorthorn cattle, Gentry in creating Gentry Berkshire swine, and many other breeders in

creating new families and breeds. It was left to the genius of Williams to write this philosophy in the language of science.

¶ ¶ ¶

Mutation Theory Most Valuable in Breeding.

The mutation theory of De Vries grows in practical importance with each passing year. Our problem in simple selection in producing clonal and self-pollinated varieties of plants consists in reducing to a fine art the seeking out of mutations and in carrying them forward till they have proven their peculiar economic worth over the very many others which must also be segregated and tried, that the best may have shown its superiority. When the selection is preceded by hybridizing we make added progress over simple selection in two ways. By recombining we can secure in one variety some choice of the most desirable of the qualities previously existing separately in two or more varieties. This selection can be more or less formal. By seeking for mutations incited under the conditions of the newly hybridized blood, there is range for the discovery of even more pronounced mutations than may be found under either parent variety or breed. Mutations are of all degrees of excellence. Only the occasional mutated character is along desired lines. The natural combination of a sufficient number of mutations in a given plant or animal to give all-round development is rare. Often many trials are necessary to recombine a mutated quality so as to combine it into an otherwise excellent network of descent. But we have only begun to develop the science, the technique, and the art of working up and segregating those networks of descent which yield the largest returns in quantity, quality, form, color, action, and even in mentality.

News and Notes

Eugenics Section.

At Cold Spring Harbor the Eugenics Record Office was opened October 1, 1910. This office is under the general direction of Dr. C. B. Davenport, secretary of the section, and under the immediate superintendence of Professor H. H. Laughlin. An office for correspondence has been fitted up and a fireproof vault, 14 by 18 feet, is being constructed. At present the Record Office maintains six workers in the field studying the pedigrees of families either in connection with or independent of institutions for defectives. These are Miss Danielson, Miss Saidee C. Devitt, Mrs. Dranga-Graebe, Miss A. B. Eaton, Dr. A. H. Estabrook, and Miss Helen Reeves. The data obtained by these field workers and, through the courtesy of the directors of the institutions at Vineland (Professor E. R. Johnstone) and at Skillman (Dr. David F. Weeks), New Jersey, by other field workers not supported by the Record Office are sent to that office to form part of a universal heredity record that will be of value for the study of defects and their transmission through successive generations.

The aid of the Record Office is also sought by institutions which wish to secure field workers. It has already supplied one institution, and part of its function is to train field workers to meet the demand. It is anticipated that, in the near future, all of the larger institutions for defectives will regard it as part of their work to maintain a field worker who shall study family histories at the homes of the patients.

Meeting of the Eugenics Section.

Members of the committees of the Eugenics Section, together with invited friends, met at the New Jersey State Village of Epileptics at Skillman, N. J., on Friday, October 14, 1910, at the invitation of the superintendent, Dr. David F. Weeks, and upon call of the secretary of the section. The purpose of the meeting was to give the field workers of the Eugenics Record Office and those employed by the other institutions an opportunity to get together with those who are directing the field

studies and to compare notes over common difficulties and methods. Actually the meeting had a far wider scope, both because well-known alienists, physicians, psychologists and heads of institutions from different parts of the United States were present and because several scientific papers of importance were read. Since Dr. David Starr Jordan, chairman of the section, who had just arrived in New York from Europe, could not be present, there was chosen as chairman of the meeting Mr. Bleecker van Wagenen, a layman well known for his devotion to the work of public institutions in New Jersey. Professor E. R. Johnstone, superintendent of the Training School at Vineland, was chosen secretary. Among the others present were Dr. George B. Wright, New Jersey Commissioner of Charities and Correction, Trenton; Dr. Henry A. Cotton, superintendent of the New Jersey State Hospital at Trenton; Dr. Everett Flood, superintendent, Monson State Hospital for Epileptics, Palmer, Mass.; Dr. William T. Shanahan, superintendent, Craig Colony for Epileptics, Sonyea, N. Y.; Surgeon George Stoner, U. S. N., in charge of the immigrant inspection service at Ellis Island; Dr. H. H. Goddard of Vineland, N. J., secretary of the A. B. A. Committee on Feeble-Minded; Dr. A. J. Rosanoff, Kings Park, N. Y., Hospital for the Insane; Dr. Madeleine A. Hollowell, superintendent, Institution for Feeble-Minded Women, at Vineland; Dr. P. F. Lange, Institution for Feeble-Minded, Glenwood, Iowa; Ada E. Sheffield, Massachusetts State Board of Charities; Dr. H. G. Schlapp, New York City; F. S. Hammond, State Hospital, Trenton; Mrs. Elizabeth V. H. Mansell, N. F. Dullard, C. Cromwell of the State Home for Girls, Trenton; Benjamin H. Crosby, New Jersey Reformatory, Rahway; Professor H. H. Laughlin, superintendent of the Eugenics Record Office, Cold Spring Harbor, and Helen T. Reeves and Saidee C. Devitt of the same office; Mrs. Caroline B. Alexander, Bernardsville, N. J.; Catherine F. Bell, Helen F. Hill, Elizabeth Kite, Maude W. Moore, Jane Griffiths of Vineland, N. J., and William H. Schultz, Dr. H. E. Diers, Dr. W. C. Smith, Dr. C. A. Mallon, Prof. J. E. W. Wallin, and Mrs. Woodward of the New Jersey State Village.

After invocation and address of welcome by Dr. George B. Wight, introduced by Dr. Weeks, the following program was carried out:

(1) Demonstration of the Binet-Simon test for mental grading, by Dr. H. H. Goddard and assistant. This demonstrated the value

of this test for determining whether, to what extent, and in what way a person is below (or above) the normal for his age.

(2) Inheritance of Insanity; abstract of a paper by Gertrude L. Cannon and Dr. A. J. Rosanoff, given by Dr. Rosanoff. This showed that (excluding certain types) two insane parents will have only insane offspring and that normal parents, both of whom belong to insane strains, will, in the long run, have one-quarter of their offspring defective.

(3) Inheritance of Epilepsy, by Drs. David F. Weeks and C. B. Davenport, based on studies made on the ancestry of epileptic patients at Skillman, and showing that epilepsy rarely, if ever, arises in families without trace of the defect even if the parents are normal. In most cases, if not all, a mental weakness may be discovered on both sides.

(4) Inheritance of Feeble-Mindedness, by Professor E. R. Johnstone and Dr. H. H. Goddard, of the Vineland School. This was a report on studies made at their institution into the ancestry of the feeble-minded. These studies have been carried on for nearly two years, and in one case a pedigree comprising more than 600 individuals has been obtained, the parents of a large proportion of whom—nearly one-half—are defective. There is good reason to suppose that this collection is not an exceptional case, and needs no comment, even as an economic proposition, as to why defectives should have at least custodial care for life and be restrained from passing on their condition, whether mental, moral, or physical.

Through the courtesy of Dr. Weeks an opportunity was offered to study the workings of the New Jersey Village for Epileptics, which is considered a model institution of its kind. Special tours of investigation were arranged and conducted personally by Doctor Weeks, entirely covering the 800-acre plant. One of the most enjoyable features was the concert furnished by the school band, which is the only one in the world entirely composed of epileptics, and which, although it has only been in existence for seven months, rendered a program requiring accurate knowledge and careful training.

On Friday evening a session was held for the purpose of arriving at standards for field workers. A system of nomenclature was adopted, which will be reported on separately. This was followed by a statement of experiences from field workers. The meeting lasted until late and was followed by an informal gathering at the "Bungalow," so

that it was early morning before the company broke up at the dormitory.

C. B. DAVENPORT, *Secretary.*

The Fourth International Genetic Conference.

The Fourth International Genetic Conference will be held in Paris, September 18 to 23, 1911, and it is to be hoped that America will show its interest in this world's question by being represented in large numbers outside of the official representation of the American Breeders Association. Mr. Philip L. de Vilmorin in a letter of recent date writes regarding this:

> The date of the next conference was first to be in May or June of next year. But when many "genetists" met in Cambridge last year for the Darwin celebration, the question was again discussed and we agreed upon the end of September to suit our American friends, because, of course, those interested in genetics, and especially in plant breeding, cannot easily leave America before August and must be back in October.
>
> I know how much interest the American scientists and breeders have taken in genetics and in the practical points of Mendel's law. The breeding of plants, cattle, poultry, dogs, and all kinds of animals has profited by the recent discussion, made for a good part by Americans, and I hope that you will point out the facts to all the members of the American Breeders Association and induce them to come to our meeting, where they will meet prominent men from all over the world and where the scientists will gather to discuss the profound riddles of heredity, and where the practical breeders may find a light to help them in their work.

Acknowledgment.

Mr. Wm. P. Rich, secretary of the Massachusetts Horticultural Society, and Mr. A. W. Latham, secretary of the Minnesota Horticultural Society, have very kindly loaned the half-tones of the portraits respectively of Mr. E. W. Bull and Mr. Peter M. Gideon, appearing in this issue of the *American Breeders Magazine*. The portrait of Prof. J. L. Budd was prepared from a photograph kindly loaned by the family. The editors are greatly indebted to the above named for their cooperation.

Need of Variety Tests.

C. E. Meyers, of the Pennsylvania Experiment Station, secured a package of Jersey Wakefield cabbage seed from each of twenty-five seed firms and grew these strains in plot comparisons for two years. He found "great difference in earliness, yields, form, and solidity of heads," and "the percentage of germination in some strains was much too low." A study of the tabulated results indicates that this form of variety testing should be widely adopted at public expense as a means of greatly increasing production.

The constant introduction of new varieties and the development of many sub-varieties or strains makes the testing of varieties at public expense practically a necessity. The cost of testing through the cooperation of State and branch experiment stations with growers is relatively small, and the cost represents only a very small fraction of the loss which may come from planting varieties and strains which will habitually yield smaller values than would the best varieties available.

Cooperation between the State and the growers at once makes the growers' business more profitable and reduces the cost of food to those who must purchase the products of the farm.

A New Body of Florists.

The American Gladiolus Society was recently organized, with a membership of 137, and held its meeting as a section of the American Florists, which convened at Rochester, N. Y. The officers of the society are: President, Isaac S. Hendrickson, Floral Park, N. Y.; vice president, E. H. Cushman, Sylvania, Ohio; corresponding secretary, L. Merton Gage, Orange, Mass.; financial secretary, H. Youell, Syracuse, N. Y.; treasurer, Maurice Fuld, Boston, Mass.; executive committee, Arthur Kirby, 35 Cortland St., New York City; Arthur T. Boddington, 342 West 14th St., New York City; J. K. Alexander, East Bridgewater, Mass.; nomenclature committee, Arthur Cowee, Berlin, N. Y.; Prof. L. B. Hudson, Cornell University, Ithaca, N. Y.; Leonard Joerg, St. James, Long Island, N. Y.

Vegetable Breeding in New Jersey.

The botanical department of the New Jersey Agricultural College Experiment Station at Brunswick, N. J., is doing considerable work in the study of vegetable breeding. A recent report of 83 pages published by Dr. Byron D. Halsted, chief of the botanical department, is devoted to a record of breeding work and variations in wild plants. The text is abundantly illustrated. The report contains the details of work and results of crosses in corn, squashes, eggplants, tomatoes, peppers, beans, and ornamental plants. In the introduction, the report states that "the desire of originating new sorts of vegetables and fruits is being replaced by a study of breeding, out of which the novelties will come as a by-product of the investigations."

Recent Publications and Articles.

The Value of First-Generation Hybrids in Corn, by G. N. Collins, Bureau of Plant Industry, U. S. Department of Agriculture, Bulletin 191, 45 pages.

Production of a New Form in Wheat, by E. G. Montgomery, Twenty-third Annual Report of the Agricultural Experiment Station, Nebraska.

Plant Breeding Studies in Peas, by F. A. Wangh and J. K. Shaw, Twenty-second Annual Report of the Massachusetts Agricultural Experiment Station, Part I.

Variation in Apples, by J. K. Shaw, Twenty-third Annual Report of the Massachusetts Agricultural Experiment Station, Part I.

The Selective Elimination of Organs, by J. Arthur Harris, Cold Spring Harbor, N. Y., *Science,* October 14, 1910.

Information Concerning the Colorado Carriage Horse Breeding Station, by John O. Williams, Experiment Station, Fort Collins, Colorado.

Self Sterility of the Scuppernong and other Muscadine Grapes, by F. C. Reimer and L. R. Detjen, Bulletin 209, North Carolina Agricultural Experiment Station.

Publications Received.

Germinal Analysis through Hybridization. George Harrison Shull. Reprinted from Proceedings of American Philosophical Society, Vol. XLIX, No. 196, 1910.

Landwirtschaftliche Studien in Nord Amerika mit besonderer Beruecksichtigung der Pflanzenzuechtung. Prof. Dr. K. v. Ruemker and Prof. Dr. E. v. Tschermak.

Ueber Bedeutung und Methoden der Saatgutzucht. Prof. Dr. K. v. Ruemker, Breslau.

Stand der Deutschen Pflanzenzucht. Reprint from Arbeit der Deutschen Landwirtschafts Gesellschaft. Prof. Dr. K. v. Ruemker.

Native Tropical Fruits. H. A. van Hermann. Santiago De Las Vegas, Cuba.

ASSOCIATION MATTERS

The Seventh Annual Meeting at Columbus, Ohio.

The Council of the American Breeders Association has decided to hold the Seventh Annual Meeting of the Association at Columbus, Ohio, February 1, 2, and 3. The meetings will be in a room provided by the National Corn Exposition on the Ohio State Fair Grounds. In addition to the three days' meeting, the Association will take a prominent part in the educational work of the National Corn Exposition. Under the auspices of the Association talks on breeding illustrated by lantern slides and moving pictures will be given in one of the lecture halls. The effort will be made at this meeting to materially enlarge the membership of the Association among plant breeders and breeders of live stock. The National Corn Exposition promises to be a most pronounced success; it has been given the use of seven magnificent show buildings on the State Fair Grounds by the State Board of Agriculture.

A strong program for the three days' meeting of the American Breeders Association is being prepared, and it is expected that this will be a large meeting with a splendid lot of committee reports, addresses, and discussions, and papers will be sent in by those who cannot attend. The Secretary earnestly requests members to write to him or to committee chairmen at their earliest convenience suggesting titles of papers they wish to present. Suggestions also of papers which might be secured from non-members, as well as members not on committees, will be welcomed.

The Association has now reached a time when an enlarged membership is an absolute necessity. The *American Breeders Magazine* makes both possible and necessary a membership of several thousand. The Association has won a very strong place in the minds of the technicians, but they are too few in number to support it; the support must come from the active and practical breeders. The National Corn Exposition has kindly set apart Wednesday, February 1, as American Breeders Association Day, and is doing much to give the Association great prominence. Secretary Wilson has been requested to give an

address in the afternoon in the great exposition auditorium. Other brief addresses will be made. Reduced rates on all railroads are expected. The National Corn Exposition is annually expanding and gives promise of developing into a great national country-life society as well as an institution to conduct an annual exhibition. Its two weeks' educational conference will discuss the organization of agriculture in a broad way.

Program, Seventh Annual Meeting.

Following, is given, in somewhat condensed form, the program of the three days' meeting. There still remain some days before the printing of the program in its final form, and it is not yet too late for members who have prepared papers or addresses to be presented at that meeting to send in titles and request a place on the program. Mail communications to the secretaries of the respective sections or to the office of the Secretary at Washington, D. C.

WEDNESDAY, FORENOON, FEBRUARY 1, 10 to 12.30.

OPENING SESSION. American Breeders Association Day. Meeting held in Exposition Auditorium. Hon. William George presiding.

Report of the Secretary. Hon. W. M. Hays.

Report of the Treasurer. Hon. N. H. Gentry.

Report of the Committee on Finance. Hon. William George, Chairman.

Appointment of Committees.

Report of Committee on Breeding Cotton. Mr. T. H. Kearney, Washington, D. C., Chairman.

Breeding for Disease Resistance in Cotton. Prof. Samuel M. Bain, Knoxville, Tenn.

Report of Committee on Nomenclature and Registration.

Report of Committee on Prize Competitions.

ILLUSTRATED TALKS. In Special Lecture Room. Separate program.

WEDNESDAY AFTERNOON, FEBRUARY 1, 2 to 5.

GENERAL SESSION. In Government Building. Dr. C. B. Davenport presiding.

Report of Committee on Breeding Corn. J. Dwight Funk, Chairman.

Plot Testing Stations as Judges of Varieties of Corn. Mr. G. N. Collins, Washington, D. C.

Report of Committee on Pedagogics of Breeding. Dean Eugene Davenport, Urbana, Ill., Chairman.

SECTIONAL BUSINESS MEETINGS, 4.20 to 5.

ILLUSTRATED TALKS. In Special Lecture Room. Separate program.

WEDNESDAY EVENING, FEBRUARY 1, 8 to 10.

GENERAL SESSION. President David Starr Jordan presiding.

Address of the Chairman of the Section, 8 to 8.20.

Address: Heredity of Defective Children. Dr. H. H. Goddard, Vineland, N. J., 8.20 to 9.

Report of Committee on Theoretical Research in Heredity. Dr. H. J. Webber, Ithaca, N. Y., Chairman.

Address: Principles of Heredity. (Illustrated.) Dr. Charles B. Davenport, Cold Spring Harbor, N. Y., 9 to 9.50.

THURSDAY FORENOON, FEBRUARY 2, 10 to 12.30.

GENERAL SESSION. Government Building. Hon. William George presiding.

New Business.

PLANT SECTION. Separate Meeting. Dr. H. J. Webber presiding.

Report of Committee on Breeding Nut and Forest Trees. Prof. George B. Sudworth, Washington, D. C., Chairman.

Possibilities of Breeding the Smaller Nuts. Prof. Geo. L. Clothier.

The Possibilities of Breeding Certain Texas Species of Trees for Planting in Warmer Semi-arid Regions. Prof. Wm. L. Bray.

The Influence of Age and Conditions of Trees upon Seed Production in Western Yellow Pine. Mr. G. A. Pearson.

Production and Development of Varieties. Mr. C. R. Keeny, Leroy, N. Y.

Report of Committee on Breeding Cereals. C. A. Zavitz, Guelph, Ontario, chairman.

Morphological Variation in Pure Lines of *Vulgare* Wheats. Herbert F. Roberts, Manhattan, Kansas.

Report of Committee on Breeding Forage Crops. Dean Thomas F. Hunt, State College, Pa.

Report of Committee on Breeding Tree and Vine Fruits. Prof. S. A. Beach, Ames, Ia., Chairman.

Report of Committee on Breeding Tea, Coffee, and Tropical Fruits. Dr. O. F. Cook, Washington, D. C.

THURSDAY AFTERNOON, FEBRUARY 2, 2 to 5.

PLANT SECTION. Government Building. Dr. H. J. Webber presiding.

Report of Committee on Breeding Tobacco. Prof. A. D. Selby, Wooster, Ohio, Chairman.

Results of Breeding Hybrid Filler Tobaccos in Ohio, 1903-'10. Prof. A. D. Selby and True Houser, Wooster, Ohio.

Comparison of Yields of First Generation Tobacco Hybrids with those of Parent Plants. True Houser, Wooster, Ohio.

A Machine for Cigar Testing. Mr. L. J. Briggs, Washington, D. C.

What Seed Selection and Breeding have done for Tobacco in Connecticut. Mr. Herbert K. Hayes, Storrs, Conn.

Report of Committee on Breeding Vegetables. Mr. W. W. Tracy, Washington, D. C., Chairman.

Report of Committee on Breeding Sugar Crops. Mr. W. A. Orton, Washington, D. C., Chairman.

Report of Committee on Breeding Cereal Crops. Prof. C. A. Zavitz, Guelph, Canada, Chairman.

Morphological Variation in Pure Lines of *Vulgare* Wheats. Prof. H. F. Roberts, Columbia, Missouri.

Report of Committee on Breeding Roses. Dr. W. VanFleet, Washington, D. C., Chairman.

Report of Committee on Pedigreed Seed and Plant Business. Eugene Funk, Shirley, Ill., Chairman.

Plant Breeding for Women. Mr. E. E. Risien, Rescue, Texas.

Report of Committee on Fiber Crops. Dean J. H. Shepperd, Fargo, N. D., Chairman.

Fibers and Fiber Plants of the Philippine Islands. Prof. M. M. Saleeby, Manila, P. I.

EUGENICS SECTION. Place of Meeting: Institution for Feeble-Minded, Columbus.

Report of Committee on Heredity of Insanity. Prof. Adolph Meyer, Baltimore, Md., Chairman.

Heredity in Recurrent Forms of Insanity. Dr. E. E. Southard, Boston, Mass.

Report of Committee on Heredity of Feeble-Mindedness. Dr. A. C. Rogers, Faribault, Minn., Chairman.

Report of Committee on Heredity of Epilepsy. Dr. N. W. Bullard, Chairman.

A First Study of Inheritance of Epilepsy. Drs. David F. Weaks and C. B. Davenport.

Report of Committee on Heredity of Deafmutism. Dr. Alexander Graham Bell, Washington, D. C., Chairman.

Report of Committee on Heredity of Criminality. Prof. Chas. R. Henderson, University of Chicago, Chicago, Ill., Chairman.

Report on Operations of the Eugenics Record Office. H. H. Laughlin.

Conference on Methods of Field Work.

THURSDAY EVENING, FEBRUARY 2, 8 to 10.

ANIMAL SECTION. Meeting in Government Building. Dean C. F. Curtiss presiding.

Report of Committee on Breeding for Meat Production.

Report of Committee on Breeding Wild Animals. Mr. D. E. Lantz, Washington, D. C., Chairman.

Domestication and Acclimatization of Wild Animals in the United States. Mr. D. E. Lantz.

Report of Committee on Breeding Draft Horses. Prof. W. B. Richards, Agricultural College, N. D., Chairman.

Report of Committee on Breeding Horse Hybrids. Dean F. B. Mumford, Columbia, Mo., Chairman.

Report of Committee on Breeding Carriage Horses. Prof. Geo. M. Rommel, Washington, D. C., Chairman.

ILLUSTRATED TALKS. In Special Lecture Room. Separate program.

FRIDAY FORENOON, FEBRUARY 3, 10 to 12.30.

GENERAL SESSION. Government Building. Hon. William George presiding.

Reports of special committees.

Election of officers.

ANIMAL SECTION. Dean Charles F. Curtiss presiding.

Report of Committee on Theory of Heredity. Prof. W. J. Spillman, Washington, D. C., Chairman.

Mendelian Inheritance of Unit Complexes. H. H. Laughlin, Cold Spring Harbor, New York.

Mendelian Inheritance in Sheep. Mr. T. R. Arkell, Durham, N. H.

Influence of Age in Jersey Sires. Prof. E. N. Wentworth, Ames, Iowa.

Report of Committee on Breeding Fur Animals. Dr. Vernon Bailey, Washington, D. C., Chairman.

Control of the Beaver under favorable conditions for the production of Fur. Vernon Bailey, Washington, D. C.

An Experiment in Fur Seal Conservation. B. W. Evermann, Washington, D. C.

The Blue Fox Industry on St. Paul and Otter Islands, Alaska. James Judge, Washington, D. C.

Report of Committee on Breeding Fish. Prof. B. W. Everman, Washington, D. C., Chairman.

Report of Committee on Breeding Bees and Other Insects. Dr. L. O. Howard, Washington, D. C., Chairman.

Report of Committee on Breeding Wild Birds. Dr. T. S. Palmer, Washington, D. C., Chairman.

Report of Committee on Cooperative Work in Animal Breeding. Hon. W. M. Hays, Washington, D. C., Chairman.

Report of Committee on Animal Hybrids. Prof. W. J. Spillman, Washington, D. C., Chairman.

ILLUSTRATED TALKS. In Special Lecture Room. Separate program.

FRIDAY AFTERNOON, FEBRUARY 3.

ANIMAL SECTION. Government Building. Dean Charles F. Curtiss presiding.

Report of Committee on Importation of Pedigreed Animals. Mr. E. B White, Leesburg, Va., Chairman.

Report of Committee on Exportation of Pedigreed Animals. Prof. H. W. Mumford, Urbana, Ill., Chairman.

Report of Committee on Establishing Types and Standardizing Judging at Livestock Shows. Col. R. B. Ogilvie, Union Stockyards, Chicago, Ill., Chairman.

Report of Committee on Breeding Swine. Prof. D. A. Gaumnitz, St. Paul, Minn., Chairman.

Report of Committee on Breeding Sheep and Goats. Prof. W. C. Coffey, Urbana, Ill., Chairman.

Report of Committee on Breeding for Dairy Production. Mr. B. H. Rawl, Washington, D. C., Chairman.

Report of Committee on Breeding Poultry. Prof. James E. Rice, Ithaca, N. Y., Chairman.

Inheritance of Gold and Silver Lacing in Hens. Dr. C. B. Davenport, Cold Spring Harbor, N. Y.

Some Character Correlations indicating Prolificacy in the Domestic Fowl. Prof. James E. Rice, Ithaca, N. Y.

Report of Committee on Plant and Animal Introduction. Mr. David G. Fairchild, Washington, D. C., Chairman.

ILLUSTRATED TALKS. In Special Lecture Room. Separate program.

There is a peculiar value in a birthday, Christmas or New Year gift consisting of a membership in the American Breeders Association.

A. B. A. Membership an Acceptable Gift.

If you have a friend whom you wish to thus honor and please, send in his nomination accompanied by membership dues.

By no gift can you pay a more delicate compliment to the intelligence and mental worth of the recipient than by presenting a membership in this large association with its cosmopolitan membership composed of persons of note as scientists, breeders, and originators of plant and animal forms, and students of genetic problems profoundly affecting economics and society.

Then, there is the *Magazine* and the Annual Report which go with the membership.

The giving of magazines as gifts is a common, commendable and friendly practice, always timely and always acceptable. The *American Breeders Magazine* lends itself splendidly to this purpose. It possesses dignity and substance. It exists not merely to amuse or entertain, but it has an aim and purpose and places each of its readers in touch with workers and thinkers who are taking a part in the world's work.

The Annual Report possesses more than book value. Between its covers it holds a summation of what is probably the latest and best information relating to heredity.

What Others Say.

You may count on me to do all that I can to promote the growth of the Association.

E. P. BENNETT,
Horticulturist Colo. Agricultural Expt. Station.

Have enjoyed the *Magazine* very much and think there is a great deal in it that would be of interest to anyone.

J. C. ROBINSON,
The J. C. Robinson Seed Co., Wholesale Growers,
Waterloo, Neb.

I have examined with a great deal of interest the two numbers of the *Magazine* and I want to say that I consider the contents as being most valuable. While some of the contributions are altogether too technical for the average layman, still I can see a great future for your magazine as a great educational medium for those who are trying to popularize what you might call "Farm Science." We will never get very far unless those who are engaged in this work have their own scientific knowledge grounded upon a rock foundation. I think your magazine will have a very pronounced effect in making what you might call "orthodox scientists."

You have undertaken a most difficult task in the standard you have made for the *American Breeders Magazine,* and I again congratulate you on the splendid start you have made.

JAMES ATKINSON,
Editor, The Iowa Homestead.

I wish to express my appreciation of the new move of the American Breeders Association in the publishing of the *American Breeders Magazine* which impresses me as a most excellent thing.

C. S. PLUMB,
Professor of Animal Husbandry,
College of Agriculture, Ohio State University.

I wish to make a study of the great material which the Association is putting out.

H. W. COLLINGWOOD,
Editor, The Rural New-Yorker.